INSTRUCTIONAL SYSTEMS: THEIR DESIGN AND POSSIBLE IMPACT UPON CHANGING CURRICULA

By

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The purpose of this study is to develop a model for designing instructional systems which might serve as a vehicle in the translation of the systems approach from a philosophical-theoretical rationale to practical applications in curricular and instructional planning processes.

Much criticism is being directed toward public education today. Many of these critics are also suggesting ways to achieve better results. Some of these criticisms are examined for suggestions they might hold for this study.

The meaning of and need for the process of model-building in education today is examined. Model-building is defined and a set of criteria for the construction of an adequate model is developed.

Historical and present models of instruction are examined and the components for each model is listed. Each model is discussed to show its basic philosophy and the implications of that philosophy to the components of the model. The investigation shows that there are three basic characteristics and at least four basic components to an adequate model of instruction. These characteristics and components are listed

and discussed.

Instructional technology is examined. The investigation indicates that thinking concerning instructional technology has been changing since the early part of the twentieth century. This change indicates that instructional technology is now being thought of as a process instead of being thought of as equipment. The steps in the process of instructional technology are delineated.

The systems approach as a process is discussed. A brief history of the systems approach indicates its recency in time. The steps in the process are described.

The investigation of instructional technology and the systems approach indicates that they are closely related processes. The similarities between the two processes are shown in tabulation form.

A nine-component model for designing instructional systems is developed. The bases for this model are 1) the adequate model of instruction, 2) the process of the systems approach and 3) the process of instructional technology. Each component of the model is described and its relationships shown. Some implications are drawn and recommendations made for the new era--the era of instructional systems.

CHAPTER I

INTRODUCTION

In The Great Didactic, Comenius said, "Let the main object of this, our didactic, be as follows: To seek and to find a method of instruction, by which teachers may teach less, but learners may learn more" (17:vi). Through the ages educators have tried to find a method or methods which will do this.

In this era when much emphasis is placed on empirical data, the words "assessment," "evaluation" and "accountability" assume great significance. There have been, and continue to be, efforts to find out what we are doing and how well we are performing in all areas of living. That education has also felt the impact of this trend is indicated in the many innovations designed to "improve" the curricula and the instructional programs of elementary and secondary schools and of colleges and universities.

Some of these innovations employ "systems thinking" in trying to solve problems of education. The use of "systems thinking," or as it is often called "the systems approach," seems to offer hope for making significant changes in the models of instruction currently being used. Advocates claim that its use in the decision-making process can make learning more dynamic and enable schools to cope better with the individual differences in learners.

Trend Toward Efficiency and Accountability in Education

Over the years we have had much criticism of public schools. The Conants, the Rickovers and the Colemans, among others, have had their

impact on education. Today we are hearing criticism both from educators and from non-educationists. The latest large-scale criticism of public education comes from a three-and-one-half year study commissioned by the Carnegie Corporation and directed by Charles E. Silberman, a former teacher, noted author and one of the editors of Fortune Magazine. His book, Crisis in the Classroom (90), tells what he found in schools across the country. Some of his conclusions are:

1. that most schools are preoccupied with order, control and routine for the sake of routine

2. that, essentially, students are subjugated by the schools

3. that, by practicing systematic repression, the schools create many of their own discipline problems

4. that schools "discourage students from developing the capacity to learn by and for themselves, being structured in such a way as to make students totally dependent upon the teachers" and promoting docility, passivity and conformity in students

5. that in most classes students are taught in a uniform manner, without regard to the individual child's understanding or interest in the subject

6. that, despite attempts at reform during the late 1950s and the early 1960s, the curriculum is characterized by banality and triviality

7. that the result of all this is to destroy students' curiosity, along with their ability and desire to think and act for themselves.

Silberman does not believe that this is so because teachers are incompetent, indifferent or cruel. He feels that most teachers are decent, honest, well-intentioned people who are victimized by the system; they are employees whose job it is to take orders and punch the time clock each day, and whose competence is judged not by what and how pupils learn, but by how well they control their classes (89).

Projects such as National Assessment and Project Talent are results of some of these criticisms. Project Talent is an effort to find out what our national needs are. The National Assessment Project will try to determine how well we are educating our young.

In his book, Every Kid a Winner, Leon M. Lessinger criticized public schools by saying, "Our dereliction as educators is all the more embarrassing because ample proof of our failures is evident. Today about one of every four American children drops out of school somewhere between fifth grade and high school graduation. In 1965, one of every four eighteen-year-old males failed the mental test for induction into the service. And a growing number of parents, reacting to information such as this, have decided that instead of labeling a large fraction of children as hopelessly stupid, we ought to ask whether the educators in charge of these children are competent to perform their task, and whether the methods they use are adequate" (74:11).

Charles Benson has indicated that low productivity is another criticism leveled at the public schools. He says that some economists have argued that we could obtain a higher productivity by moving schools into the private sector. This, he feels, would prod school officials to make more efficient use of resources (7:71). Alvin Toffler, on the other hand, believes that the schools are not looking in the right direction. In Future Shock he states, "What passes for education today, even in our 'best' schools and colleges, is a hopeless anachronism. . . . our schools face backward toward a dying system, rather than forward to the emerging new society" (99:398).

Other indications of dissatisfaction with the present public

school system include: student rebellion; voucher system plans; possible federal aid to parochial and private schools; performance contracting; and citizen groups urging fewer "frills" and more concentration upon the "basics." Two of these, voucher systems and performance contracting, deserve more elaboration.

Behind the voucher system plan is the idea that public education is not doing the job that it should; that competition between schools for clients (students) would improve the system; that such competition should be between public, private and parochial schools; that the student and his parents should choose, from among the assorted schools, the one best satisfying his needs; and that the cost of tuition, or at least part of it, should be provided through a voucher system (42, 62, 68).

While voucher systems would encourage competition between differing types of schools, performance contracting would bring private business companies into the educational system. Under a performance contract plan, the local school board contracts with a concern which guarantees a specific pupil performance within a specified period of time. The first of these contracts was let in the Texarkana, Arkansas and Texarkana, Texas School Districts (37). This five-year program, although not complete, has been followed by similar contracts in such school systems, among others, as Philadelphia; Dallas; Gary, Indiana; and Cherry Creek, Colorado (37, 84, 85). In all such programs, the contractor is held accountable for producing the desired performance. His payment depends upon results obtained (69).

In the past, school systems have been accountable only for where

the money was spent and not for educational results obtained. Most people are held accountable for their work and are expected to earn their salaries by producing results. Deterline commented about this:

> There is, however, a never-never quality about the instructional world that says, "You are the professional, you are the competent person here, and the students are dependent upon you. Yet we won't hold you accountable if they fail to learn from you; we'll blame them. We will hold them accountable for any failures, deficiencies and incompetence in your teaching. And we will use the instructional setting as a screening device: if the students can not learn in spite of what goes on here, we will penalize them. Their records will show that their intelligence and motivation were not enough; and sometimes those records will haunt them, and affect their careers, and their lives. You will not be affected in any way. You are not accountable for the results of your activities." (33:16)

Lessinger said, "Our schools are somehow failing one youngster in four, and we have not acted to arrest the social and economic fatalities which every school dropout represents. It is no wonder, then, that critics such as Paul Goodman and Edgar Friedenberg feel that many dropouts are better off on the street than in the classroom" (75:13).

Lessinger continued by saying:

> What it [the public] expects from its investment is educated children, able to meet their own needs and society's needs to the full measure of their potential.
>
> In his Education Message in 1970, President Nixon stated, "From these considerations we derive another new concept: 'Accountability.' School administrators and school teachers alike are responsible for their performance, and it is in their interest as well as in the interest of their pupils that they be held accountable." (75:14)

George Gallup indicated that the public does indeed lean toward requiring accountability for results in education. His 1970 poll showed that the public favors 1) students in local schools being given national tests so that their educational achievement may be compared with

that of students in other communities, 2) a system that would hold teachers and administrators more accountable for the progress of students, and 3) each teacher being paid on the basis of the quality of his work (49:101).

Instructional Systems as Tools for Providing Efficiency and Accountability

If education is to be held accountable for the performance of learners, then it must be provided with the tools for accomplishing all aspects of the job. Ervin Harlacher and Eleanor Roberts stated this premise thusly, "It is one thing to make an administrator accountable if he has the modern tools with which to work; it is quite another to hold him accountable if he's using a hand plow to do a job that requires a bulldozer" (56:30). Alvin Toffler said,"Attempts by the present educational leadership to revise the physics curriculum, or improve the methods for teaching English or math are piecemeal. . . . we need more than haphazard attempts to modernize. We need a systematic approach to the whole problem" (99:411).

Luvern L. Cunningham has addressed himself to some of the problems of accountability.

> Accountability and evaluation, as I use the terms, are not synonymous. Accountability is dependent upon evaluation, obviously, but it is a broader concept. The accountability responsibility extends beyond appraisal; it includes informing constituencies about the performance of the enterprise. Similarly, it implies responding to feedback. . . . (28:285)

> Accountability as sought in these instances appears to have two dimensions. The first is access to information about performance. The second is ability to change those factors thought to be responsible for unsatisfactory performance. (28:287)

Conrad Briner has indicated that accountability should use engineering-like management practices.

> Accountability as only a professional exercise is unrealistic. Accountability as a combined community and educator political exercise is workable.
>
> In support of this thesis, I propose certain assumptions and strategies. First, that in one manner or another students can be taught and they can learn; second, that human and financial resources will continue to be scarce; and third, that the educational management process can include participation of various publics in determining priorities of educational needs, source and manner of allocating resources, and types and uses of evaluation. These assumptions all defer to a new management technology that involves stating instructional objectives, defining performance criteria, monitoring, auditing, and correcting instructional activities within the context of local, state, and national political processes.
>
> The basic strategy of accountability in these terms is to employ participative decision-making to shaping educational policy and evaluation and a highly detailed plan of educational management. What should be incorporated in educational management is careful reasoning about teaching and learning that is similar to engineering work. The desired result of instruction is made explicit; known alternative ways of accomplishing this are simulated to ascertain feasibility in terms of needed public and professional approval, available personnel, space and time, and of course, cost. The activities selected are then evaluated. Should the known ways of doing an educational job not be successful enough, invention is required and, accordingly, research and development work including experimentation and innovation will be the handmaiden of the engineering-like management practices. (12:205)

Lessinger also indicated that educational engineering can be a tool of accountability.

> Accountability can prepare the way for and support the process of educational engineering. Once we have thorough, relevant, and reliable data on programs of instruction, we naturally raise questions about how we can increase their effectiveness or lower their cost, or possibly both. And with experience in framing performance criteria, we naturally wonder about revising or extending our educational goals.

> In the process of educational engineering we consider these questions not in vague, global terms, but point by point. If a machine malfunctions, engineers immediately look for specific causes. They test the variables, the performance of each part of the assembly, to find out what is going wrong. Rather than reject the machine, question the capability of its operators, or condemn the factory system of production, they go straight to the specific question of what is wrong with the machine.
>
> We can apply a similar approach to education. Instead of blaming the learners, the teachers, their environments, the school system or various parts of it, we can learn to define carefully the performance we want to isolate and the factors that seem to be causing the difficulty, and assure quality by a series of specific changes instead of half-launching or talking to death one grand program after another. (74:32-33)

The idea of a field of educational engineering is not new. As early as 1945, W. W. Charters raised the issue in an article entitled, "Is There a Field of Educational Engineering?" (21). He answered his own question in another article, "The Era of the Educational Engineer" (20). He defined the educational engineer as "anyone who intelligently builds efficient methods of performance." By "intelligent building" he means defining objectives, planning, building, operating, and measuring efficiency (20:233).

> The engineer will identify the idea to be worked upon, analyze it, and select promising hypotheses concerning its practical uses. He will experimentally play with plans for building a structure that will use the full value of the idea. He will build the unit--a curricular unit, an operational technique, an instructional method. He will operate the tool and try it out in practice. He will test the results to measure the efficiency and practicality of what he has constructed. These engineering methods will be perfected in the light of experience and practice, and a growing body of educational-engineering techniques will develop over the decades. (20:234)

In the last few years the techniques that Charters was referring to have been called "The Systems Approach." With reference to account-

ability, Deterline and Kaufman have also indicated that the systems approach can be used as a tool for accountability. Deterline in his article, "Applied Accountability," indicated that, for accountability, education must 1) select goals and objectives, 2) determine and specify the objective criteria, 3) assemble learning experiences and evaluation and management procedures that will allow and assist each student to reach the specified criterion or set of criteria, and 4) rely on the evaluation data produced and make any changes necessary (33:19).

He stated that "Total accountability means that each component has a specified function; we have to determine how well each component succeeds and revise and improve where necessary. Accountability also means that we must identify the weaknesses and provide corrective back-up so that no student is lost to us" (33:19).

Kaufman would have education apply the systems approach to the effort of achieving accountability, noting that Lessinger "assisted in providing the neonate with tools for achieving a realistic accountability. These tools include (but are not limited to): Auditing, System Analysis, and the System Approach" (66:21).

He said further that "Still other tools exist, and are used by those concerned with the quantitative improvement of education. These additional tools include Needs Assessment, Behavioral Objectives (or perhaps even better, Measurable Performance Objectives), Planning, Programming, Budgeting Systems (PPBS), Systems Analysis, Methods-Means Selection Techniques, PERT (Program Evaluation Review Technique) and other related network-based management tools, testing and assessment" (66:21). This led him to state that "If we educators, then, are going to be accountable, it would be well if we had tools by which we could (1) determine what we

will be accountable for accomplishing, (2) determine methods for achieving predictable results, (3) determine methods for deciding among alternatives, (4) determine methods for the management and control of educational operations, and (5) determine methods for ascertaining the extent to which needs and associated objectives have been met" (66:21).

To this point this writer has described some of the present criticisms of public education and the remedies suggested by some of those who have made these criticisms. Some authorities have suggested that instructional systems, designed through the use of the systems approach, may be used for achieving a greater degree of efficiency and accountability in education. Assuming there is merit in such suggestions, there is a need to develop a practical framework for designing instructional systems.

Purpose and Method of the Study

The central purpose of this study is to develop a framework for designing instructional systems and to project the implications of their use in public education. It is hoped that this model will provide a vehicle for moving from a philosophical-theoretical rationale to practical applications in curricular and instructional planning processes.

The study will include several aspects of investigation: 1) the emerging relationship between instructional systems design and general systems concepts; 2) the relationships between instructional systems design and educational technology will be examined; and 3) major implications for public education will be projected.

Until recently the systems approach was used mainly by industry, government and the military; therefore, much of the material pertaining to this study may be derived from those sources. However, since the study will be focused upon those aspects of the systems approach which

appear to have applications for designing instructional systems for public education, the study will not be limited to the above mentioned sources. These materials will include the writings, speeches, and reports of programs of those who have addressed themselves to the systems approach concept. The major criterion for the selection of material to be included in this study will be its relevance to the investigation.

Because the central purpose of this study is to develop a framework for designing instructional systems and to project the implications of their use, it has involved the writer in in-depth reading, analyzing, organizing and synthesizing. From this a model is developed which should be of value to professional educators and prospective teachers. In order to make the conceptualized model as broadly useful as possible, technical data have been treated on as non-technical a level as is consistent with clarity.

Inasmuch as many of the topics with which this investigation is concerned are philosophical and/or practical in nature, and, inasmuch as there are diverse positions concerning them, no attempt will be made to provide a comprehensive treatment of <u>all</u> points of view.

Definition of Terms

If, as has been suggested, the systems approach can be used as a tool for moving toward greater efficiency and accountability, there must be a clear understanding of certain terms. The following definitions, selected from several authorities, provide the functional definitions needed for this study. Additional terms, as needed, will be defined in the body of this dissertation. It must be recognized, however, that these may change and that this list may be

lengthened or shortened as the study proceeds.

System.--"A system is the structure or organization of an orderly whole, clearly showing the interrelationship of the parts to each other and to the whole itself" (92:367).

Systems Approach.--"The systems approach is a way of looking at a process . . . a methodology which enables us to analyze a complex problem and then to synthesize a solution" (96:432).

Systems Design (in Education).--"Provides a conceptual framework for planning, orderly consideration of functions and resources, including personnel and technical facilities such as television, the kinds and amount of resources needed, and a phased and ordered sequence of events leading to the accomplishment of specified and operationally defined achievements. A systems approach should provide a way of checking on the relation of performances of all components to factors of economy, and should reveal any inadequacies of the several components, including the faults of timing and consequently of the entire system" (38:76).

Instructional System.--"An integrated, programmed complex of instructional media, machinery, and personnel whose components are structured as a single unit with a schedule of time and sequential phasing. Its purpose is to insure that the components of the organic whole will be available with the proper characteristics at the proper time to contribute to the total system, and in so doing to fulfill the goals which have been established" (38:76).

Instructional Technology.--". . . instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching

in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction" (26:19).

Educational Technology.--"Educational technology can be understood as meaning the development of a set of systematic techniques, and accompanying practical knowledge, for designing, testing, and operating schools as educational systems. Technology in this sense is educational engineering" (48:9).

Educational Engineer.--"The engineer will identify the idea to be worked upon, analyze it, and select promising hypotheses concerning its practical uses. He will experimentally play with plans for building a structure that will use the full value of the idea. He will build the unit--a curricular unit, an operational technique, an instructional method. He will operate the tool and try it out in practice. He will test the results to measure the efficiency and practicality of what he has constructed" (20:234).

CHAPTER II

TOWARD AN ADEQUATE MODEL OF INSTRUCTION

Historical and archeological evidence indicates that man has been constructing metaphors and symbols for almost all of his existence. They have functioned to help create order and have become tools for man to use in trying to shape his environment. As tools they have provided the basis for conceptualizations from which explanations and predictions about the nature of things may be made. Man has developed his ability and powers for constructing metaphors to the point that, when confronted with a problem, he attempts to solve it by using concepts, ideas, and notions with which he is familiar.

Today these metaphors are called "models" and are used in many areas of life. In recent years model-building has achieved much prominence. As Heinich noted, "Models are 'in,' and any process, condition, or structure worth its salt is fair game for model builders" (59:23). This is borne out in Griffith's statement that "One of the most used words in social science research today is model" (53:122).

In this chapter the endeavor will be to:

1. examine briefly the meaning and need of model-building

2. summarize the special features of outstanding historical and current models of instruction

3. describe the characteristics or components of an adequate instructional model and state the criteria for the construction of such a model.

Meaning and Need of Instructional Models

Griffiths says, "The impression gained from a reading of the literature and from listening to social scientists is that any somewhat systematic presentation of ideas is a model. A discussion is generally prefaced by, 'Now, my model is . . .'" (53:122). This notion was expressed by Meadows in 1957 when he stated, "Even a casual reader of current research literature gets the impression that the word 'model' is one of the latest things in scientific language. This word is a roving beam that spotlights such various things as experimental design, postulate sets, deductive paradigms, theories, concepts, even language itself" (83:3).

What, then, are "models" and what purposes do they serve? From reading the literature, it is apparent that definitions of the word "model" contain one or more of the following descriptors; analogy, description, or representation. Bronowski defines a model as a description of the way nature is organized (13:23). Travers defines it as an analogy (100:59). Alkin (3), Heinich (59) and LeBaron (72) define a model in much the same fashion as do Hill and Kerber when they write, ". . . a scientific model might be thought of as a representation of some subject of inquiry (e.g., objects, processes, systems) . . ." (60:15). The purposes of models are 1) to interpret (43:62), to explain (3:3), 3) to describe (13:13), and 4) to aid in understanding (100:59). Thus the term model can be defined as an analogy to, a description of or a representation of a subject of inquiry for the purpose of interpreting, explaining, describing or aiding in the understanding of that phenomenon.

Education has not escaped the phenomenon of model-building. The

profession has long used this procedure. An examination of titles in current professional literature indicates that "model-building" is "in " (1, 4, 5, 76 and 79).

If model-building is to be more than a fad, educators must look at each proposed model and determine its worth and model-builders must try to achieve completeness in their models. The effectiveness of a teacher, a school or a school system is circumscribed by the kinds of instructional models that are implemented. According to the critics and research, many of the current instructional practices are inadequate for providing the required conditions for effective learning. As indicated in Chapter I, page 3, Leon Lessinger criticizes the current instructional practices and gives as proof the fact that about one out of every four American children drops out of school between the fifth grade and high school graduation. He has said that ". . . a growing number of parents, reacting to information such as this, have decided that instead of labeling a large fraction of children as hopelessly stupid, we ought to ask whether the educators in charge of these children are competent to perform their task, and whether the methods they use are adequate" (74:18).

Teachers have also indicated that many classroom instructors lack sufficient knowledge and capabilities for valid planning and for implementing the appropriate instructional procedures to provide the conditions for meaningful and successful learning. In a study of teacher preparation, the NEA Research Division asked this question, "In terms of your actual teaching needs, to what extent did your undergraduate teacher preparation program prepare you in the following areas?" (98:34). Of the scientifically selected cross section of the nation's 1.5 million

public school teachers 97% replied to the question. The following is a tabulation of those replies.

	Preparation was: Too little	About right	Too much
Depth of knowledge in subject fields in which you specialized	27.0%	71.2%	1.8%
General education--some knowledge in many fields	19.9	75.9	4.2
Psychology of learning and teaching	25.8	66.4	7.8
Human growth and development	23.2	72.1	4.7
Teaching methods	40.6	49.1	10.3
History and philosophy of education	15.1	64.2	20.7
Use of audiovisual equipment and materials . .	60.1	38.1	1.8

(98:34).

It is interesting to note that nearly 41% felt that they had received too little preparation in teaching methods and that more than 60% indicated a need for more preparation in the use of audio-visual equipment and materials. This is indicative of the need to formulate an adequate instructional paradigm or model.

Instructional Models of the Past and Present

Any attempt to formulate such a model should first answer the question, "What are the components of an adequate instructional model?" To answer this question one needs to look at past or historical instructional models, at present models, and at the current research and theorizing regarding the nature of valid instructional models.

Models of Early Times

Time and space do not allow all historical models to be examined. Three models have been selected because they cover the entire continuum from early Greek education until the end of the nineteenth century and also represent efforts to systematize the process of instruction.

The Sophists and the teaching of rhetoric

The Sophists are frequently called the ancestors of the teaching profession. "They become self-conscious about teaching as an art, and this of necessity led them to the consideration of method" (14:6). Broudy also said that ". . . the teaching of rhetoric involved three factors: nature, art and exercise. . . . The art was summed up in sets of definitions, precepts or rules, and classifications. The exercises consisted of practice tasks in imitating the best models the instructor could set before his pupils" (14:7).

According to Broudy and Palmer, the teaching procedures followed by the Sophists were the following:

> 1. The pupil would memorize the definitions, classifications, and rules as embodied in textbooks.
> 2. The teacher would analyze the models to be imitated by a prelection.
> 3. The pupil was directed to apply the precepts and imitate the model in practice declamations or compositions on hypothetical themes.
>
> The imitation, which was the heart of the method, was obviously not a simple duplication of the model. Good imitation involved:
> 1. Giving the student the results of careful study of the model by the teacher to reveal how the author achieved his effects. This analysis was offered by the teacher either in a lecture or by assigning material covering this point in a textbook (cf. Quintilian Institutio, II, v.6-16).
> 2. Asking the student to write sentences that exhibited the

> stylistic characteristics of the model: periodic sentences, certain figures of speech, etc. Exercises in imitation included learning by heart, learning by translation from Greek to Latin, and paraphrasing poetry into prose. (15:26)

The instructional model used by the Sophists was very formal and rigid. It was instructor developed and directed. The student was not free to choose what or when to study a particular phase of the program. Although there might be some flexibility on the part of the instructor, the very definiteness of the curriculum left little doubt in the mind of the pupil as to exactly what was expected of him.

The components of the instructional model used by the Sophists included:

1. selection of goals or objectives
2. presentation of instruction
3. practice
4. assessing the progress of the student.

The Jesuit model

The Jesuit model of education exemplifies the formal, classical methods of teaching used in many of our schools and colleges today. Jesuit schools flourished from the sixteenth through the nineteenth centuries, and their prominence continues in some parts of the world today. Broudy has described the Jesuits as "masters of method" (14:22). They seemed to have had a genius for organizing and systematizing every phase of schoolkeeping, including materials, methods and teachers, into a uniform and effective instructional system. Motivation, presentation, practice and testing were reduced to rules and precepts. The Ratio Studiorum, or Plan of Studies, first published in 1586, brought together

their rules and precepts for teaching (15:88).

Eby too has pointed out that early Jesuit schools were not concerned with all grade levels, stating:

> The educational work of the Jesuits has been exclusively on the secondary and higher levels. Only in a few instances where primary schools were not available has the Order reluctantly supplied instruction. Obviously the Order did not credit the old slogan: 'Give me a child until he is seven and I do not care who has him after that,' for elementary education was never regarded as an indispensable part of its program. (36:111)

Early Jesuit schools confined themselves to the education of boys above ten years of age. They required exclusive control over the training of the boy and would not share this control with the influence of the home or any other agency. The Society had no program for girls and, more significantly, had no program for the education of the masses (36:114).

Instructional goals of the Jesuit schools included the acquisition of a high degree of skill in writing, speaking, reasoning and criticizing. These skills were to be achieved through mastery of Latin and Greek, logic, natural and moral philosophy, metaphysics, theology, and sacred scripture (14:22-25; 36:108-114). This curriculum was standard and the student had to accommodate himself to the instruction. The method of presentation, therefore, tended to select the student rather than allow the student to select the method of presentation.

The Jesuits had highly developed instructional procedures. Their chief method of presentation was "prelection," in which the instructor studied assignments aloud in front of the class. To illustrate the prelection of an oration or a poem, Broudy and Palmer quote from the <u>Ratio Studiorum</u>:

> If an oration or poem is being explained, first its meaning must be explained, if it is obscure, and the various interpretations considered. Second, the whole method of the workmanship, whether invention, disposition, or delivery is to be considered, also how aptly the author ingratiates himself, how appropriately he speaks, or from what topics he takes his material for persuading, for ornament, or for moving his audience; how many precepts he unites in one and the same place, by what method he includes with the figures of thought the means of instilling belief, and again the figures of thought which he weaves into the figures of words. Third, some passages similar in subject-matter and expression to be adduced and other orators or poets who have used the same precept for the sake of proving or narrating something similar are to be cited. Fourth, let the facts be confirmed by statements of authorities, if opportunity offers. Fifth, let statements from history, from mythology, and from all erudition be sought which illustrate the passage. At last, let the words be considered carefully, and their fitness, their elegance, their number, and their rhythm noted. However, let these things be considered, not that the master may always discuss everything, but that from them he may select those which are most fitting. (15:88)

According to Broudy and Palmer, the most important aspect of the Jesuit instructional method was the way the teacher secured overlapping review. Each and every segment of instruction was reviewed immediately after completion of the work. Students reviewed the work of the week on Saturday and, for general promotion, they reviewed thoroughly the work for the entire year. Thus, ". . . the master's prelection, the week's work, the term's work, the year's work were all reviewed" (15: 91). Eby has described this method as memorization.

> As to method of instruction the whole reliance was upon memorizing word for word the material to be acquired. The mind had to be stored with just that knowledge and information that pertained to the central purpose in view. The ancient slogan, <u>repetitio mater studiorium</u> (repetition is the mother of learning) was never more adroitly practiced by any group of teachers. First the lesson for next day was carefully explained to the pupils; then they learned it by heart; and then by systematic reviews daily, weekly, monthly, and annually, it was indelibly stamped upon the memory until it became an integral part of the mind itself. (36:112)

In addition to the prelection and overlapping reviews, which were used as teaching devices for presentation and memorization, the Jesuit schools used the disputation, or formal debate, and rivalry as teaching devices for motivating students. Also included in their system was a type of performance assessment. The standard was mastery of the material and its retention for a year or more. This performance assessment was accomplished by the teacher, or student assistants, checking all the numerous assignments and returning them to the student; by tests; and by frequent reviews which, in themselves, uncovered what was learned and how well.

It should be noted here that there were no conscious variations in objectives or procedures to accommodate differences among and between students. All students were expected to achieve the same objectives in about the same way, through rote learning.

In brief, the components of the Jesuit model may be described as follows:

1. determination of goals or objectives
2. motivation of the student
3. presentation of new material
4. practice in old and new material
5. assessment of student performance.

The Herbartian model

Early in the nineteenth century Herbart wrote several books devoted to education. Because of these works he has been called the "father of the modern science of education" (36:473). His approach to

the study of the science of education was direct. He recognized that education is an art, and that the first task of the educator is to discover the ultimate ends or objectives of education. Next he would have educators discover the proper means for the accomplishment of those objectives (36:473).

His pedagogy contained certain basic ideas which led to definite instructional procedures. Broudy and Palmer feel that

> Pedagogically, Herbart's system is important because it makes instruction a controllable process of building idea clusters that constitute the apperceptive mass. Each idea cluster can be thought of as carrying a power index, or exponent, so that theoretically, at least, one might have a calculus of probabilities as to what choices the individual will make, given the power of values of his ideational components. (14:37; 15:132)

When referring to some of the basic psychological beliefs held by Herbart, Cole has said that

> He believed that the mind at birth was a blank and possessed innately only one power, that of entering into relation with its environment by means of sense perception through the workings of the nervous system. The mind was therefore built up through the presentation of ideas from the external world, not through the development of its own innate faculties, of which it has none. . . . The main business of education is therefore the imparting of the most useful knowledge in such a way that it can be most easily grasped and most completely retained by children. (25:496)

Herbart maintained that teachers should be conscious of the fact that learning involves an internal change and that new ideas must strike a responsive chord in the mind of the student. New ideas must be developed in the student's imagination. This can be accomplished only when the student is truly interested (82:277).

From the standpoint of his pedagogy, Herbart felt instruction involved four requirements.

1. It must be concrete. Instruction must start with illustrations if the senses are to be stirred.

2. It must be continuous. Since students cannot make progress without effort, continuous exercise is needed.

3. It must be elevating. Students must be imbued by the adventure of ideas.

4. It must have application to life. Action is superior to theoretical contemplation; therefore, knowledge is to be lived and experienced (82:277).

Herbart's system was formalized by Herbart and his followers into five formal steps. Mayer briefly defined these steps as follows:

> 1. Preparation. The environment is created - both external and internal - for the development of ideas. Old ideas are recalled from the subconscious and attention is cultivated.
> 2. Presentation. The lessons are presented to children with the use of illustrations to make them as concrete as possible.
> 3. Association. Both similarities and differences between old and new ideas are stressed. This develops order and consistency in thinking.
> 4. Generalization. This is a method of qualitative simplification, so that more and more facts can be understood in their wider meaning.
> 5. Application. Knowledge must be used and become part of our daily existence. (82:278)

The Herbartian model, then, would include the following five components:

1. selection of objectives

2. determining the proper means for the accomplishment of the objectives

3. presentation of lesson

4. practice

5. application of new concepts to life.

Models of the Current Scene

Present-day thought and research concerning instruction and learning can also provide insight into the components necessary for an adequate model of instruction. Many learning theorists suggest that learning theories in and of themselves provide adequate instructional models. This position is not felt to be true by other researchers who, involved directly with research pertaining to instruction, hold that learning theories 1) do describe and explain the conditions under which learning does or does not occur, 2) do not prescribe the most effective ways of achieving learning, and 3) do not provide criteria for determining when learning has taken place.

In discussing the relation of a theory of instruction and learning theories, Jerome Bruner said that

> A theory of instruction is prescriptive in the sense that it sets forth rules concerning the most effective way of achieving knowledge or skill. . . . A theory of instruction is a normative theory. It sets up criteria and states the conditions for meeting them. . . . But theories of learning and development are descriptive rather than prescriptive. They tell us what has happened after the fact. . . . A theory of instruction, in short, is concerned with how what one wishes to teach can best be learned, with improving rather than describing learning. (16:40)

Glaser has also indicated that learning theories are not immediately available for practical use. He feels translation and development are required before practical applications can be made. He stated, "The assumption, too often made in the past, that the findings and theories of learning could be presented directly to educators for their use is not viable" (51:706).

Bruner and Glaser would agree that learning theories cannot be used as instructional models, but that learning theories, as well as

learning principles derived from relevant descriptions of classroom learning, can serve as the foundation for the development of an adequate instructional model.

Three current models will be discussed here. They were selected because each is an attempt to specify ways in which instruction can best be accomplished.

The Gagne model

Probably the most comprehensive description of classroom learning is found in The Conditions of Learning by Robert M. Gagne. He points out that there are many kinds of learning and that each one ". . . begins with a different state of the organism and ends with a different capability for performance" (47:60).

Gagne recognizes that the organism's initial state or starting point composes the prerequisite conditions which distinguishes one form of learning from another. He also concluded that these prerequisites are connected in a hierarchical fashion, and suggested the following categories and hierarchy of learning:

> Problem solving,
> requires as prerequisites:
> Principles,
> which require as prerequisites:
> Concepts,
> which require as prerequisites:
> Multiple discriminations,
> which require as prerequisites:
> Verbal associations,
> which require as prerequisites:
> Stimulus-response connections. (47:60)

Gagne said that understanding how learning operates in everyday situations can illuminate some of the activities of the curriculum planner, the course designer and the instructor, such as:

Planning for learning.--Planning must be done in terms of the student's capabilities before and after any learning enterprise. It must specify the learning structure of any subject to be acquired and must order the prerequisite capabilities within the topic to be learned (47:24).

Managing learning.--The management of learning must provide for motivating the student by arousing his interest before and holding it during the learning enterprise. Managing learning must provide for determining and advising the student concerning further learning enterprises. Managing must also provide for the assessment of the student's achievements for the purpose of informing him of what he has been able to achieve through the learning situation (47:25).

Instructing.--Instructing means arranging the conditions of learning that are external to the student for the purpose of bringing about efficient learning. These conditions must be constructed in a stage-by-stage fashion so that the previously acquired capabilities of the student can be taken into account and the attainment of the capabilities needed for the next stage of learning can be attained. The activity of instructing, whether it be by the teacher or through some other mode, is at the heart of the educational process (47:26).

Selecting media for instruction.--Instructional media are often called "resources for learning." The conditions for learning can be put into effect in different ways and in differing degrees, depending upon the particular form of media chosen. When these resources for learning are placed in some particular arrangement they are called a mode of instruction. The choice of the mode to use is aimed at secur-

ing optimal functioning in generating the proper conditions for learning (47:28).

For Gagne, then, an adequate instructional model would need to provide for the following:

1. identifying the learner's current performance capabilities

2. specifying each of the performance capabilities in an hierarchical fashion

3. planning, selecting and presenting instructional sequences which are consistent with the learner's capabilities and the performance to be achieved

4. assessing the achievement of the learner.

The Bruner model

In Toward a Theory of Instruction, Jerome Bruner sets forth his theorems for a theory of instruction. He states that a theory of instruction

> . . . should specify the experiences which most effectively implant in the individual a predisposition toward learning--
> . . . must specify the ways in which a body of knowledge should be structured so that it can be most readily grasped by the learner.
> . . . should specify the most effective sequences in which to present the materials to be learned.
> . . . should specify the nature and pacing of rewards and punishments in the process of learning and teaching. (16:40)

For Bruner, learning depends upon the exploration of alternatives. This exploration must be facilitated and regulated by instruction. He defines regulation as "activation," "maintenance," and "direction," meaning that the ". . . exploration of alternatives requires something to get it started, something to keep it going, and something to keep it from being random" (16:43). For the exploration of alternatives to have

direction he feels 1) that there must be a goal or objective for the task, 2) that this goal must be known to the learner, and 3) that the testing of alternatives must yield information to the learner as to where he stands in relation to the goal.

Bruner believes that there must be concern for devising a structure of knowledge whereby complex generalizations build upon basic principles. This structure must be consonant with the capabilities of the learner and relatable to his cognitive structure. The adequacy of the knowledge structure will be determined by its power to simplify and translate that body of knowledge for the learner without contradiction to other structures from the same body of knowledge. "Any idea or problem or body of knowledge can be presented in a form simple enough so that any particular learner can understand it in a recognizable form" (16:44).

There are various sequences for learning any body of knowledge, and no one sequence is suitable for all learners. The optimum sequence for a particular learner will depend upon several factors, including his past learning and state of development, the way he differs from others, and the nature of the material to be learned. Thus, instruction can consist of leading the learner through a sequence of statements and restatements so as to increase his ability to grasp, transform, and transfer what he is learning (16:49).

With regard to the pacing of rewards and punishment, Bruner said that "learning depends upon knowledge of results at a time and place where the knowledge can be used for correction. . . . 'Knowledge of results' is useful or not depending upon when and where the learner receives the corrective information . . ." (16:50). This indicates that there

should be a set of criteria against which the instructor and the learner can judge the learner's progress.

Bruner's model may be described as having the following five components:

1. providing a predisposition toward learning
2. selecting goals or objectives
3. structuring the body of knowledge to be taught
4. sequencing of material to be taught
5. providing immediate knowledge of results.

The Glaser model

In the 1966 Yearbook of the National Society for the Study of Education, The Changing American School, Robert Glaser proposed an instructional model similar to the Bruner model:

1. analyzing the characteristics of subject matter competence
2. diagnosing preinstructional behavior
3. carrying out the instructional process
4. measuring learning outcomes (50:217).

An examination of these components gives some insight into Glaser's thinking. First, the subject matter domain would be analyzed in terms of the performance competencies which comprise the domain. It would be analyzed in terms of the "stimulus characteristics" and the kinds of responses that these characteristics elicit from learners. The structural characteristics of the domain would also be analyzed to determine possible hierarchical arrangements and operating rules. From these analyses specific instructional and performance objectives would be derived.

Second, there would be an analysis of the past performance of the learners to determine what they presently know and can do and how their knowledge and competencies may facilitate or interfere with the new learning.

The third part of Glaser's model is the task of moving the student from his ". . . preinstructional behavioral state to a state of subject-matter competence" (50:217). This would include all the procedures necessary to accomplish the instruction; construction of teaching procedures and materials, sequencing of materials, scheduling of reinforcements, providing adequate motivation, and the administration of these procedures.

Finally, this model would provide for an evaluation of the student's performance in relation to established criteria.

Characteristics and Criteria of an Adequate Instructional Model

It is apparent from this examination of current and historical models that any adequate model of instruction will have several qualities or characteristics. First, it will be diagnostic in that it provides for the identification of 1) instructional objectives, 2) instructional procedures, and 3) the learner's capabilities and current level of operation. Second, it will be prescriptive in that it specifies the instructional procedures necessary to produce optimal learning conditions. Third, it will be normative in that it provides a set or sets of criteria for determining when the objectives have been achieved.

Another way of describing such a model would be that it must contain a minimum of four components: a statement of instructional objec-

tives, a procedure for evaluating student capabilities, a description of instructional procedures, and a method for assessing achievement. The first component will show the objectives the learner should be able to attain upon the completion of instruction. The second will indicate the student's capabilities for entering upon a specific period of instruction. The third will describe the procedures necessary for leading the learner through the planned sequences of materials and knowledge. The last component will consist of the tests and observations to be used in determining how well the learner achieved the objectives. In brief, these components may be stated as:

1. objectives
2. preinstructional capabilities
3. instruction
4. evaluation.

In addition to being certain that these characteristics or components are present in his model, the model-builder must also observe certain criteria for the construction of an adequate model. Such criteria have been described by several authorities.

In the Thirty-Fourth Yearbook of the National Council for the Social Studies, New Perspectives in World History, Engle says that a model must be comprehensive (40:560). His intent is that it should explain the phenomenon in its totality and complexity and that it explain both the regularity and variation.

Novotney (87:25), writing for the American School Board Journal, described a good model as :

1. having wide applicability; it must be useful in many situations

2. providing a framework for viewing the relationship between all elements in a meaningful fashion; from the model the user must be able to determine the relationships that exist between the various components of the model, and must understand the impact each has upon the other
3. offering the possibility of creating order where chaos may otherwise exist; that is, it should order the phenomenon.

LeBaron (72:6-9) listed five characteristics by which the value of any type of model may be judged. The model:

1. must be complete; it must explain the whole system
2. must reflect an operational reality; it must consider the solution in relation to the systems ability to implement and accomplish the solution
3. must be understandable; the user must be able to perceive the workings of each component of the model
4. should encourage further analysis within the area of interest; the model should foster a complete analysis of the situation and the proposed solutions
5. should encourage feedback; information concerning the functioning of the system is used to adjust and better achieve the goals of the system.

A set of criteria for model-building can be used in at least two ways: 1) it can be used by the model-builder to insure that his model is well constructed; 2) it can be used by other persons to judge between two or more models they are considering for possible use. From these authorities the following set of criteria is derived:

1. The model will structure the universe to which it applies.

2. The model will be comprehensive for its universe.

3. The model will provide the framework for viewing all its components.

4. The model will show the operational reality of each component.

5. The model will show the operational reality between components.

6. The model will show the feedback within and between components.

7. The model should encourage further analyses within the universe which it structures.

8. The model should be understandable.

9. The model should have wide applicability.

CHAPTER III

TOWARD A TECHNOLOGY OF INSTRUCTION

Recent years have seen great advances in the development and use of new media, methods and materials of instruction and considerable progress toward a technology of instruction. To understand this movement, we need to see it in historical perspective.

This chapter will endeavor to present the derivation and development of an instructional technology and show its relation to the systems approach. Specifically, three things will be done:

1. trace the development of instructional technology
2. trace the development of the systems approach
3. show the relationships between these two movements.

The Development of Instructional Technology

If tracing the development of instructional technology were to be an historical analysis only, it would be necessary to review further the contributions of the Jesuits and Herbart as pioneers and that of the Sophists as the ancestors of this movement. Since most of its evolution has occurred in the very recent past, the development of a technology of instruction may be considered a twentieth-century movement, and our consideration will be with its progress during this century.

John Dewey in Democracy and Education set the stage for some of the later developments when he stated:

> . . . the only way in which adults consciously control the kind of education which the immature get is by controlling the environment in which they act, and hence think and feel. We never educate directly, but indirectly by means of the environment. Whether we permit chance environments to do

> the work, or whether we design environments for the purpose makes a great difference. And any environment is a chance environment so far as its educative influence is concerned unless it has been deliberately regulated with reference to its educative effect. . . . schools remain, of course, the typical instance of environments framed with express reference to influencing the mental and moral disposition of their members. (35:22)

Three people stand out as major contributors to the development of this movement. They are W. W. Charters, Edgar Dale, and James D. Finn. This section will describe their contributions in detail and will also indicate some of the contemporary thinking which is building upon their works.

Contributions of W. W. Charters

In his first book, Methods of Teaching Developed from a Functional Standpoint (22), published in 1923, W. W. Charters embraced the Herbartian five-step lesson plan and enlarged it by including a step prior to its use. This step provided for an analysis of the function and structure of the subject matter.

In his second book, Curriculum Construction (19), Charters expanded his ideas on the need for analysis. In summarizing his first chapter he stated:

> Summarizing, we may say that in order to determine the content of the curriculum the aim of education must be stated in terms both of ideals and of activities. When the aim is stated in terms of ideals only, there is always a gap between the aim as stated and the curriculum as ostensibly derived from such a statement. Conversely, when the activities are stated without the ideals which dominate them, there is no means of selecting the proper methods of performing the activities. (19:11)

Charters began Chapter II with a section entitled, "The result of failure to analyze" (19:12). In Chapter IV he stated that

> Analysis of activities is not an unfamiliar operation. It has long been used as a method of instruction, but its application has not been wide and the present emphasis upon analysis is an effort not so much to use a new method as to make wide application of a method which has been used for a long time in a few situations. (19:34)

He ended that chapter by declaring, "In determining the activities upon which instruction is to be given, analysis is necessary. . . . Without such analysis we are entirely at a loss to know how to proceed in building the curriculum" (19:40).

Charters indicated that statements of objectives of education and/or subjects should be analyzed into two categories: ideal objectives and activity objectives. He described ideal objectives as the desired goals and activity objectives as those activities which demonstrate the attainment of the ideal (19:52). He stated that "Man has a mental stride with which he marches from one goal of civilization to another" (19:56). He felt that the objectives of education must be placed into working units and that the stride of the working units should vary according to the learners. "The working units into which material has to be broken are dependent upon the learner rather than upon the subject matter. If he is young and immature, the steps into which the material has to be broken must be smaller, whereas if he has greater maturity detailed explanations are not necessary" (19:58).

Continuing his discussion on the importance of analysis, Charters stated:

> The perfect analysis is one which is carried to the point where the student can learn without assistance. If it is put into the form of a book, the ideal text is one which teaches itself. In it the material is so expertly presented that the student understands everything, can follow it through to its end, incorporate it in his experience, and use it in his life

> of action. . . . Theoretically, this would mean a different curriculum for every learner, since each student has capacities different from those of every other student, and to meet these a curriculum would need to be carried to different levels of working units. (19:60)

Charters emphasized that the work units should be carefully selected and ordered so that they will meet the needs of the learners. After this selection and ordering of units, he felt that materials for instruction must be collected and selected prior to the time the instruction is to be given and that throughout all of these steps the learner must always be kept in mind.

Very succinctly, he summarized his ideas of curriculum construction in seven steps.

> First, determine the major objectives of education by a study of the life of man in its social setting.
>
> Second, analyze these objectives into ideals and activities and continue the analysis to the level of working units.
>
> Third, arrange these in the order of importance.
>
> Fourth, raise to positions of higher order in this list those ideals and activities which are high in value for children but low in value for adults.
>
> Fifth, determine the number of the most important items of the resulting list which can be handled in the time allotted to school education, after deducting those which are better learned outside of school.
>
> Sixth, collect the best practices of the race in handling these ideals and activities.
>
> Seventh, arrange the material so obtained in proper instructional order, according to the psychological nature of children. (19:102)

Continuing the thoughts and ideas begun in his early writings, Charters, in 1945, raised the question of whether or not there is a field of educational engineering. In his article, "Is There a Field of Educa-

tional Engineering?" (21), he compared the activities of the engineering profession to those of some practitioners in education and translated the "engineering method" into the vocabulary of education.

> First, the educational engineer accepts an idea to develop, a problem to solve, or a question to answer. . . . his next step is a logical definition of the problem. . . . When a problem has been defined, the educational engineer analyzes it to discover the factors that must be considered. . . . Having completed his plans, he proceeds to construct his project by carrying out the operations which have been specified in the manner decided upon. . . . The final phase of the engineering method in education is evaluation. (21:36-37)

Six years later Charters was still advancing the cause of engineering in education. In what is probably his last published paper, "The Era of the Educational Engineer" (20), he stated:

> As one surveys the widespread interest, the broad range of activities, now apparent across the nation, he does not need to be a visionary to detect the emergency of an engineering era in education. I shall define educational engineering by answering the question, Who is the educational engineer? Anyone who intelligently builds efficient methods of performance is an educational engineer. Intelligent building means defining objectives, planning, building, operating, and measuring efficiency. (20:233)

These are the same five skills that he had suggested six years earlier.

Charters was not content, however, merely to contemplate this emerging era. He looked forward toward its development by making several predictions.

> I have the temerity to forecast the probable trends of future changes. I predict a change of emphasis in the next half-century in the field of education. This shift will be from the exploration of educational ideas and concepts to the development of techniques for putting them into practice. The five methods used by the educational engineer will continue to be used. The engineer will identify the idea to be worked upon, analyze it, and select promising hypotheses concerning its practical uses. He will experimentally play with plans for building a structure

> that will use the full value of the idea. He will build the unit--a curricular unit, an operational technique, an instructional method. He will operate the tool and try it out in practice. He will test the results to measure the efficiency and practicality of what he has constructed. These engineering methods will be perfected in the light of experience and practice, and a growing body of educational-engineering techniques will develop over the decades. (20:233-234)

> The sciences of human behavior have not yet developed a constancy in measurement remotely approaching that of physical phenomena. Some day psychological measurements may be as accurate as physical measurement. (20:234-235)

> Research laboratories will expand their geographical areas to include the schools of the nations, because good engineering techniques demand that methods developed in the laboratory be tried out in practice before their validity is demonstrated and prior to their release for general use. (20:235)

> I predict concerted national action in the field of educational engineering. The task of building an efficient body of methods in usable form cannot be left to individual initiative. (20:237)

> These activities which probably, if not certainly, will be carried on in an expanding future, will be aided by psychology and sociology, the supporting interest of the public, and the active interest of the profession. Men of engineering temperament, who wholeheartedly believe that construction of efficient programs, methods, and techniques has professional priority, may well congregate and organize themselves into an enthusiastic and potent group to strengthen the interest of the profession in these matters, to encourage each other, and to propose programs of action. The need is urgent. The time is favorable. (20:246)

Contributions of Edgar Dale

Throughout the first half of the twentieth century audiovisual education was the main field concerned with developing the use of technology in education. Although during this period most of the practitioners in this field seemed to be more concerned with the devices of technology than its processes, there was one leader and spokesman who was concerned with these processes and the better utilization of materials.

This person was Edgar Dale, a former student of W. W. Charters. He wrote the first textbook in the field of audiovisual education, publishing Audio-Visual Methods in Teaching (30) in 1946. It dealt more with process and the proper utilization of materials than with machines.

An important feature of this book was inclusion of his "Cone of Experience," an effort to classify into an hierarchy of experiences the many possible experiences that can be provided. The broad base of the cone represents direct, purposeful experiences. All other experiences fall between the base and the apex, with verbal symbols, the most complex experiences of all, at the apex. Dale's "Cone of Experience," and his explanation of its use, has probably had more influence on the philosophical and psychological rationale of the field of audiovisual education than any other conceptual schema.

The contributions of Dale did not stop with the publication of that text. In the revised edition, 1954 (31), his discussion on planning, organizing and evaluating offered three suggestions for the planner. First, the planner must devote attention to the broad physical and psychological environment of the learners, giving consideration to their mental set toward the material to be learned, the physical setting, and the general and specific learning climate. Second, he must consider four successive stages: 1) selecting the objectives or changes in behavior sought; 2) motivating by attending the needs and interests of the learner; 3) practicing the new learning; and 4) testing, evaluating and offering other experiences as necessary. Third, there should be an integrated approach in which specific learnings are related to larger objectives (31:395).

In 1967, at the Florida Audiovisual Association meeting, Dale

moved still closer to a technology of instruction. At that time he stated:

> We know that all of these instruments teach, there isn't any doubt about that. . . . The issue is, what arrangement can we make so that they teach more than they ordinarily would be expected to? How can we program?
>
> What we need to know is when do you use a recording? When do you use television? When do you use a book? When do you use a paperback and etc.? Now you have got to think about the whole range of materials and you've got to orchestrate the whole business. No simple task. . . . It can be an overwhelming problem unless you people get together and, in a sense, parcel out some of these jobs. You don't have to do them all alone. But most of all you've got to have some notion of where the goal is. Now, what is the goal? The statement I make about the goal is that every child, every adult, must have access to excellence. It must be easily available. . . .
>
> We can't now provide easy access to excellence in teaching for every child. Excellent teacher! But we can provide access to the mediated teacher, the mediated instructor, the film, the recording and all the rest of them. . . .
>
> We make available here a cafeteria of learning materials so that varied needs can be served. . . .
>
> Well, what's ahead of us in the future? I think one thing is, we've got to do a much more rigorous examination of our goals of the terminal behavior sought. What we expect the student to do after he has run the instructional course. And if the student fails or learns inefficiently we ought to first look at his learning experience to see what is wrong. Would you agree with me that if the typical student does not learn, the chances are that he has not been systematically taught? . . .
>
> Sometimes we know what to do but we don't know how to do it fast enough. We are not nearly as productive as we can be, but we have not done the necessary curriculum engineering, or planning, if you prefer that term. We can be both more effective and more efficient. Well, what do you do about it? Well, you've got two responsibilities, I think. One of them is to work with teachers and administrators to rethink the goals of the school or the college. And second, to help them develop the best combinations of rich experiences for reaching those goals. (29)

By the time the third edition of Audiovisual Methods in Teaching (32) was published in 1969, Dale was projecting more and more use of technology for planning. Part III of that edition was entitled, "Systems and Technology in Teaching." In this section Dale emphasized the importance of instructional technology as the key to the use of the systems approach in teaching. He said:

> The increased use of instructional technology in school and college aims: (1) to change the role of the teacher so that he can put increased emphasis on those learning processes which require close personal relationships with students, and (2) to design a learning and teaching environment in which the learner has more self-direction in the management of his own development.
>
> The technology used in instruction, therefore, should be a boon to education, not a danger. It can help provide every person with access to excellence.
>
> Technology, clearly, is not a machine; it is a planned, systematic method of working to achieve planned outcomes--a process not a product. Technology is the applied side of scientific development. (32:610)

Contributions of James D. Finn

At the beginning of the second half of this century another figure, James D. Finn, was emerging to advance the principle of instructional technology. Finn, a student of Edgar Dale, was influenced by the views of both Charters and Dale, and his contribution to the field of educational media reflected the ideas of both men. In an early paper, "Automation and Education: III. Technology and the Instructional Process," Finn attempted to describe the relationship between technology and the educational process.

> Technology relates to education in at least three major ways. First, in a society in which science and technology are primary, such as America, the society requires that

> the educational system insure an adequate supply of scientists and associated technicians. This requirement sets a curriculum problem, an organization problem, and many other problems. . . . Second, as a society becomes more and more technologically oriented and controlled, the question of the general education of all citizens is raised. The survival and management of the whole society theoretically requires more general education in the sciences and technology for all. . . . Third, because of the tendency for technology to have no limits and constantly to extend into new areas, it is inevitable that, in an advanced technical society, technology should begin to extend into the instructional process itself. (44:10-11)

Finn expressed concern that many teachers and administrators consider technology as machines only. The following quotations indicate his feelings with regard to this limited understanding.

> A new world, . . . seems to be forming within the educational society. This world is technological in nature. Men are seeking to solve some of the problems of education by technological means. Technology is not, as many of the technically illiterate seem to think, a collection of gadgets, of hardware, of instrumentation. It is, instead, best described as a way of thinking about certain classes of problems and their solutions. (46:29-30)

> . . . to equate machines and materials with technology is to admit a monumental misunderstanding of technology. For technology involves systems, organization patterns, procedures, various forms of analysis, research and development, etc. . . . Viewed in the large, technology is . . . a way of thinking about problems and the feasibility of the proposed solutions. Instructional technology, then, is the application of this concept to the problem of the use of man-machine systems in instruction. (45:101)

> The educationist, in considering the effect of technology on the instructional process must remember that, in addition to machinery, technology includes processes, systems, management and control mechanisms both human and non-human, and above all, . . . a way of looking at problems as to their interest and difficulty, the feasibility of technical solutions, and the economic values--broadly considered--of those solutions. This is the context in which the educator must study technology. (44:10)

Contemporary Ideas

Others have contributed to the definition of instructional technology. The entire issue of Educational Technology for January, 1968, was devoted to instructional technology. In one article Donald P. Ely pointed out the utility of the definition developed by the Department of Audiovisual Instruction Commission on Definition and Terminology which states:

> Educational technology is that branch of educational theory and practice concerned primarily with the design and use of messages which control the learning process.
>
> It undertakes: (a) the study of the unique and relative strengths and weaknesses of both pictorial and nonrepresentational messages which may be employed in the learning process for any purpose; and (b) the structuring and systematizing of messages by men and instruments in an educational environment. These undertakings include the planning, production, selection, management, and utilization of both components and entire instructional systems.
>
> Its practical goal is the efficient utilization of every method and medium of communication which can contribute to the development of the learner's full potential. (38:18-19)

He indicated that the key terms in this definition are "branch of education theory and practice," "design and use," and "control." For Ely, technology "offers a contemporary thrust which encompasses the use of a systematic body of facts and principles, related to a practical end" (39:7). He concluded by stating:

> Educational technology blends the science of learning with the art of teaching. Each extreme by itself is insufficient to achieve the goals which American Education has set for all who are parts of this giant mosaic. But to deny that teaching and learning are both an art and a science is to deny both the man and the machine which are the fundamental elements of educational technology. (39:7)

In the same issue of Educational Technology, Robert E. Silverman

indicated that there may be more than one type of technology when he said, "However, in analyzing the various uses of the term, I detect a pattern of differences that suggests there may be two kinds of educational technology. One kind of technology emphasizes techniques and/or devices. The other kind of technology places more emphasis on principles and on rationales" (91:3). He designated the first as relative technology and the second as constructive technology. Speaking of constructive technology, he said:

> Constructive educational technology is more basic; it deals with (1) the analysis of instructional problems; (2) the selection or construction of measuring instruments needed to evaluate instructional outcomes; and (3) the construction or selection of techniques or devices to produce the desired instructional outcomes. (91:3)

In that same issue, Robert Heinich referred to technology as ". . . one of the most misunderstood words in our language--particularly when applied by educators to education" (58:4). In defining instructional technology, he went on to say:

> Educators tend to define technology simply by its obvious manifestations: machines. It is an easy step from this to the simplistic view that if we have machines, we are using technology, and if we haven't machines, we are not engaged in a technological process. . . . As technology applies to instruction . . . any move toward analysis of curriculum into specific objectives and then devising means of achieving them is a step in the direction of technology. . . . The blending of the technologies of instruction into an operational man-machine instructional system is the job of instructional technology. (58:4)

In a later issue of Educational Technology, Charles F. Hoban defined the concept of instructional technology in terms of management of the various facets of the instructional process, saying:

> Essentially, instructional technology, in its modern usage, involves the management of ideas, procedures, money,

> machines, and people in the instructional process. As such, it involves:
>
> (1) a physical device(s) which mediates information transmission;
>
> (2) a system of instruction of which this device(s) is one of several components; and
>
> (3) a range of mediating options involving progression in (a) requirements for physical alteration of the "classroom;" (b) remoteness in time and space between the tutor-planner and the student; (c) sophistication of design of programmed information exchange between "tutor" and student; (d) complexity and cost of hardware; (e) level of technical skills required for equipment construction, installation, "de-bugging," operation, and maintenance; (f) independence from classroom teacher control or continuous monitoring in the operation of the device centered "teaching;" (g) additional manpower required by way of paraprofessional personnel for use of the instructional technology; and (h) role changes and new skills required of "classroom" teachers in (I) management of the technology, and (II) other and/or new non-structured, non-mediated teaching activities essential to personality development, humanistic growth, and cultivation of values, all of which lie outside the present and foreseeable potential of instructional technology as herein considered. (61:6)

In the Peabody Journal of Education for July, 1969, Stuart Lusty defined instructional technology as ". . . a process that deals with the analysis of instructional problems, the evaluation and production of instructional outcomes, and the devices necessary for such analysis, evaluation and production" (77:54).

The November, 1970, issue of Educational Leadership was sub-titled "Technology and the Further Reach." In the editorial with the same title, Harry A. Johnson said, "Instructional technology will find its place in school programs with a more systematic approach to instruction and an

arrangement of resources whereby students respond and learn through a variety of strategies and materials. . . . In the careful design, development, and testing of instructional systems, both industry and the armed forces have moved ahead of the schools" (64:120).

R. Louis Bright, while an Associate Commissioner in the United States Office of Education, wrote:

> Educational Technology is not synonymous with hardware, as many people seem to think; rather, it is . . . an instructional theory or approach which may or may not involve hardware. . . . Modern educational technology is based on two fundamental principles. One is that the objectives of any educational system should be designed to create behavioral changes in the students. . . . The second major principle for utilizing educational technology is that the course, not the student, is at fault if the desirable change in student behavior does not occur.
>
> The emphasis of educational technology is on student achievement; hence, educational technology usually is concerned with individualizing instruction. It permits each student to assimilate the material at his own pace so that learning becomes a completely individualized experience. (11:8)

One other indication of an attempt at definition should come at this point. It is taken from <u>To Improve Learning: A Report to the President and the Congress of the United States</u> by the Commission on Instructional Technology, which was composed of both lay members and professional educators. The Commission said:

> Instructional technology can be defined in two ways. In its more familiar sense, it means the media born of the communications revolution which can be used for instructional purposes alongside the teacher, textbook, and blackboard. In general, the Commission's report follows this usage. In order to reflect present-day reality, the Commission has had to look at the pieces that make up instructional technology: television, films, overhead projectors, computers, and the other items of "hardware" and "software" (to use the convenient jargon that distinguishes machines from programs). In nearly every case, these media have entered education independently, and still operate more in isolation than in combination.

> The second and less familiar definition of instructional technology goes beyond any particular medium or device. In this sense, instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction. The widespread acceptance and application of this broad definition belongs to the future. Though only a limited number of institutions have attempted to design instruction using such a systematic, comprehensive approach, there is reason to believe that this approach holds the key to the contribution technology can make to the advancement of education. It became clear, in fact, as we pursued our study, that a major obstacle to instructional technology's fulfillment has been its application by bits and pieces.
>
> Instructional technology, by either definition, includes a wide array of instruments, devices, and techniques, each with its particular problems, potential, and advocates. Note, however, that neither definition equates technology with "machines"--an easy mistake to make. To put prime emphasis on <u>equipment</u>--e.g., films, coaxial cable, teaching machines--can lead up a blind alley. (26:19-20)

<u>Summary</u>

Educational and instructional technology is mainly a twentieth-century development in education. The early genealogy of the concept of instructional technology indicates three persons whose thoughts have evolved into what is now termed instructional technology. This genealogy, Charters, Dale, and Finn, has yielded the most productive thinking about this new field which has developed to date. A concise statement of the definition which has evolved from their ideas is found in the report of the Commission on Instructional Technology ". . . instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research

in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction" (26:19).

The Development of the Systems Approach

Another concept was emerging at about the same time that Charters, Dale, Finn and others were developing the concept of instructional technology. This concept developed outside the educational system but will no doubt have a marked effect upon the definition and evolution of instructional technology. This is the systems approach. Through instructional technology and the development of instructional systems, it will possibly affect the entire system of education.

History of the Systems Approach

The systems concept or systems approach is not altogether new. The concept of "system" can be traced to ancient civilizations in which the universe was viewed as a system. It can also be traced through philosophy, science, mathematics and logic to its present usage and interpretation. It has been used in science to develop the orderly nature which enabled man to develop a logical understanding of the nature and theoretical system about him.

Today there seems to be disagreement about the name of the systems approach concept. In the current literature a number of different terms seem to be equated with it. Although in some cases there seem to be differences in their meanings, all refer essentially to the same process. This concept will be found described under such terms as:

1. Operations Research (2, 57, 58 and 88)

2. Systems Analysis (57, 63, 93, 96 and 102)

3. Systems Research (102)

4. Operations Analysis (6, 8, and 102)

5. The Scientific Method (41, 67 and 73)

6. Problem Solving (67 and 103)

7. Systems Engineering (27)

8. Systems Approach (6, 10, 23, 24, 86, 94, 103 and 104)

It should be noted that in several instances different names have been used in the same article or used by the same author.

According to Ackoff the birth of operations research is "usually dated back to about 1939" (2:2). Speaking of its early roots in industry and its growth along with industry, Ackoff said, "It is the executive's responsibility to establish policies and practices that in some sense best serve the interest of the organization as a whole. . . . This integrating task requires taking the whole system into account" (2:3). This function developed gradually as the organizations developed during the period between World War I and World War II.

This same type of development also took place in the military between World War I and World War II. But during that period military technology began to develop more rapidly than it could be absorbed effectively into tactics and strategy. Small wonder then that the British military would seek help early in World War II. Of this phenomenon, Ackoff wrote that

> Specifically, they sought aid in incorporating the then-new radar into tactics and strategies of air defense. Small teams of scientists, drawn from any disciplines from which they were willing to come, worked on such problems with considerable success in 1939 and 1940. Their success bred

> further demand for such services and the use of scientific teams spread over the Western Allies, the United States, Canada and France. These teams of scientists were usually assigned to the executive in charge of operations--to the "line"--and hence came to be known as Operational Research in the United Kingdom and by a variety of names in the United States. . . . (2:4-5)

After World War II for Britain, and the Korean Conflict for the United States, these OR (Operations Research) men came out of the military and were absorbed by industry and government. The concepts of operation research were beginning to spread and expand, and the talents and techniques of these men came to be used to help solve complex problems ranging all the way from those concerned with the operation and functioning of a single company to those encountered in the space program. From business, industry and government, these techniques have been introduced into the operation of the public schools.

Definition of the Systems Approach

Many definitions of the terms "systems" and "systems approach" have been used. "System" is largely concerned with organization and structure, while "systems approach" is more concerned with process. The definitions listed in Chapter I, page 11, continue to apply. They are:

System.--"A system is the structure or organization of an orderly whole, clearly showing the interrelationship of the parts to each other and to the whole self" (92:367).

Systems Approach.--"The systems approach is a way of looking at a process . . . a methodology which enables us to analyze a complex problem and then to synthesize a solution" (96:432).

The systems approach uses the concept of the whole system in developing the process of analysis and synthesis. Although the process

used is important, the idea that there is interaction (feedback) between all elements of the system is a major feature of all systems using this method. This means that, at any time or point in the process, there can be a change if it is found to be necessary. Any definition that does not provide for this type of interaction would not adequately serve the system.

The Systems Approach Process

With regard to the process of Operations Research (OR), Ackoff has described three essential characteristics and six stages.

> Definitions of OR should not be taken too seriously. In order to grasp its meaning we should rely more on understanding its essential characteristics, but a definition may be a useful guide to discussion of these characteristics. OR can be said to be
>
> (1) research on problems involving the control of organized (man-machine) systems to provide solutions which best serve the purposes of the organization as a whole
>
> (2) by interdisciplinary teams
>
> (3) through the application of scientific method
>
> The essential characteristics of OR identified in the definition are (a) its systems (or executive) orientation, (b) the use of interdisciplinary teams and (c) the application of scientific methods to problems of control. . . .
>
> Summarizing, we have identified six stages of an OR project:
>
> 1. Formulating the Problem
> 2. Constructing the Model
> 3. Deriving a Solution
> 4. Testing the Model and Evaluating the Solution
> 5. Controlling the Solution
> 6. Implementing the Solution. (2:7-12)

Launor F. Carter of the Systems Development Corporation has identified eight steps to be used.

1. State the real NEED you are trying to satisfy.
2. Define the educational OBJECTIVES which will contribute to satisfying the real need.
3. Define those real world limiting CONSTRAINTS which any proposed system must satisfy.
4. Generate many different ALTERNATIVE systems.
5. SELECT the best alternative(s) by careful analysis.
6. IMPLEMENT the selected alternative(s) for testing.
7. Perform a thorough EVALUATION of the experimental system.
8. Based on experimental and real world results, FEEDBACK the required MODIFICATIONS and continue this cycle until the objectives have been attained. (18:22-23)

Tucker, on the other hand, indicated only four key elements in the systems approach: 1) objective setting; 2) planning; 3) quality control; and 4) efficiency (101).

Roger A. Kaufman has designed a model in which five steps are designated. These five components are:

1. identify the problem
2. analyze the problem and set goals
3. select the solution strategy from the alternatives
4. implement the solution strategy
5. evaluate the performance effectiveness. (67:418)

A feedback loop connects each component to each of the other components. Kaufman has also divided these five steps into two categories. The first category consists of two steps and is called system analysis. The second consists of steps three, four, five and the feedback loop,

and is called system synthesis. System analysis has as its purpose the breaking down or description of all the parts of the system and determining their relationships to each other. System synthesis has the effect of putting together those parts needed to make the system work most efficiently.

The number of steps used in the systems approach may vary from model to model, but the essential steps seem to be:

1. analysis of the problem
2. stating of the objectives
3. determination of possible solutions
4. determination of the best solution or solutions
5. implementation of the solution
6. evaluation of the solution performance
7. feedback from each step to every other step.

Some Training Uses of the Systems Approach

The systems approach has been used by industry and by the military in devising training systems. Only a few instances of each will be cited here.

Launor F. Carter reported the use of the systems approach in the development of a training program for personnel in the Back-Up Intercepter Control (BUIC) III Air Defense System (18). In this instance the development was done by psychologists of The Rand Corporation. Carter's eight-step model was used in developing the training program. Some modifications were made during the implementation and testing phase. The program was successful.

Concerning the use of a systems approach, Carter indicated that

it involves a systematic and rational set of procedures for attacking a problem and forces planners to think through the flow of activities from beginning to end in order to achieve a successful outcome. He pointed out that in some few cases it may not be possible to follow all steps as they are outlined, that modifications may be necessary. In summary, he said that his system is a point of view and a set of procedures. It not only enables a careful examination and systematic attack upon problems but also lays out a schedule of activities and emphasizes the areas in which problems may arise. He cautioned, however, that the use of the systems approach does not assure a successful outcome. It only makes it more likely (18).

Alan L. Hanline reported the successful use of the systems approach in planning the job training programs for the Clearfield Job Corps Center at Clearfield, Utah. Some of the problems included hindrance in the use of off-the-shelf materials due to the extremely low grade-level reading capability of the trainees, attitudes of the instructors toward the Center's training program, and obstacles in the use of audiovisual devices (55).

M. Robert Talley, the Director of Training for Travelers Insurance Companies, reported the efforts of that company to improve training. The problem first arose with the issuance of a new policy which would be sold in forty different states. The system and methods department devised the programs of self-instructional materials. A job/task analysis was performed to define the procedures to be taught. Behavioral objectives were developed for each unit. Presentation devices were selected and production of the programs accomplished. The system was implemented

in 1968 and included programmed texts, tape recorders, filmstrips and simulation exercises. Evaluation of the results indicated that the employees were better trained and equipped to perform their complex tasks, that the new product was implemented more easily and that error rates were down (97).

The Human Resources Lab (HRL), headquartered at Brooks Air Force Base, Ohio, is a combination of their former Behavioral Research Labs and Personnel Research Labs under the Air Force Systems Command. Their mission included, among other things, analysis, design and management of local studies, and the conduct and evaluation of research activities. The systems approach is used in this function. Their efforts over a two-year period at Chanute Air Force Base training center resulted in a saving of 648 student man-years, with the required performance level being retained (81).

The U. S. Army also uses the systems approach in its training programs. HumRRO (Human Resources Research Organization) performs this function for the Army. Saul Lavisky has reported some of the activities and publications of that organization. Although originally a part of The George Washington University, HumRRO is now an independent, nonprofit corporation. It was established in 1951 at the specific request of the Army. Its mission was to conduct studies and research in the areas of training, training-device requirements, motivation and leadership. The position of HumRRO has been that all aspects of instructional technology must be considered as part of the complete system. To accomplish the assigned mission, a seven-step systems approach model was devised (71:18-25).

During the past twenty-one years HumRRO has published approximately

1,000 reports and professional papers which discuss aspects of its operations. The following descriptions are indicative of successes achieved.

Technical Report 70-8 described the development and evaluation of an improved radio operator course. The duties of a radio operator were analyzed and arranged into specific tasks to be taught in sequence. A new training program was developed and its effectiveness evaluated. Results were compared with those from "standard" classes. The results showed that, despite the fact that revised classes were 40% larger than the standard class, there were substantially fewer trainees who had to be recycled and the failure rate was greatly reduced (52).

Technical Report 69-25 reported the results of a training program for HAWK radar mechanics. The reason for development of the new program was the high student failure rate in standard classes. At the end of the two-year experimental period, results obtained were compared with results for standard classes. In each comparison, the attrition rate of the new program was as low as or lower than that of the standard classes and the end-of-course performance was equal to or slightly superior to that of the standard classes (34).

Technical Report 69-102 was an interim report. It described the analysis conducted to determine the jobs performed and the skills needed for Coast Guard search and rescue missions. The analysis was performed for each of the four different aircraft used in such operations. The reported analysis showed the desirable characteristics for simulation training devices and provided the basis for the development of operationally oriented training programs (54).

In Professional Paper 21-70, McFann and Heyl presented four

factors that HumRRO has found to be very important in training personnel of different aptitudes. These factors are 1) structuring and sequencing of content, 2) examining the complexity level of written materials, 3) selecting methods and media, and 4) using incentive systems for motivation. With reference to these factors, they said:

> First, structuring and sequencing of content in ways appropriate to the trainee group has proven consistently to be beneficial. This organization and sequencing of material is helpful for the high ability trainee but is most important for the low ability person. One aspect of this structuring is the establishment of relevance or meaningfulness of the material to be learned. The establishment of such relationships is an essential characteristic . . . sequencing and structuring requires that training content be organized so that the intended use of new instructional material is established for the learner prior to the introduction of the material itself. The principle follows simply from the fact that people learn and retain best those new things that can somehow be tied in with something already known. Ancillary to the principle are certain working rules: (a) go from the concrete to the abstract; (b) go from the specific to the general; (c) go from practice to theory; (d) go from the familiar to the unfamiliar.
>
> This principle implies that subject matter material is arranged and integrated into meaningful tasks. It is task- or problem-oriented . . .
>
> A second factor that we have found to be very important and one that should be taken into account is examination of the complexity level of the written materials, such as job aids, or Field Manuals and Technical Manuals. Recent information that we have collected in which the reading ability of the trainee and also the job incumbent is compared to the readability, or difficulty level, of the material that he is to use, indicates that there is considerable discrepancy between what the average trainee can comprehend and the level of complexity of the written material he is required to use in training.
>
> Further, there is information indicating that when the material is written at a level that the trainee can comprehend, he will use the material. Time does not permit going into greater discussion of this general area of examination of material, but, clearly, the format of the material

as well as the complexity level and difficulty level of the written words are all very important and need to be considered. . . .

A third general area in the instructional process concerns the methods of instruction or the media that are to be employed. As might be expected, the methods or media employed with a high aptitude subject or learner are not nearly as important as for individuals with lower aptitude. One view, hopefully facetious, is that in spite of our methods of instruction the brighter, more able person will learn. This cannot be stated, even facetiously, for the less able person. In fact, data we have indicate that method of instruction becomes extremely critical in determining whether or not the lower aptitude individual can or will learn the material.

If material is presented at a level that he can comprehend, if it is presented in the functional context manner, if it is individually paced, if he is provided considerable support, if he is in a learning situation where he can ask questions and receive answers, if the material is organized so that he is learning small bits of information at a time, and if he is given an opportunity to practice and participate actively in the learning process, then he will be able to learn and will learn material that varies considerably in complexity.

It is apparent that there is no one medium or method that is appropriate for all individuals. Ideally, then, one wants to present a variety of methods or media so that the individual can choose those most appropriate. . . .

I will comment briefly on the area of motivation and the use of incentive systems. We have tested formally in the laboratory the effects of tying incentives directly to the learning process. . . . since there is no question about the soundness of the principle, the problem is to work out an effective and feasible system.

I have touched on some major points of application of educational technology in HumRRO research concerned with the relationships among aptitude level, training content, and instructional procedure. We have much more to learn before we can speak with any degree of certainty as to how best to design instructional systems for personnel with different aptitude levels. We are, however, optimistic that we are getting better approximations to a definitive answer as our activities progress. (78:18-21)

Summary

The systems approach has been defined as a process or methodology which enables planners to analyze a problem and synthesize a solution. It has been used to derive solutions to some very complex problems. It has been used successfully to help design training programs in business, industry and the military. Listed here are the steps or characteristics most often found to be used in the systems approach:

1. definition and analysis of the problem
2. stating of the objectives
3. determination of possible solutions
4. determination of the best solution or solutions
5. implementation of the solution
6. evaluation of the solution performance
7. provision for feedback from each step to every other step.

Common Elements of Instructional Technology and the Systems Approach: A Synthesis

Instructional technology and the systems approach are concepts which have deep roots in history but in the main are twentieth-century developments. Both are processes or methodologies for solving problems. While the systems approach may be used for solving problems in general, instructional technology is applied to a more specific set of problems, those involved in the design and management of instruction. Development of the systems approach has added the element of feedback to the process derived from the Charters - Dale - Finn genealogy. Thus instructional technology becomes a self-correcting system.

Figure 1 provides a comparison of the steps followed in both the systems approach and instructional technology. A study of this comparison shows that the use of instructional technology for the design of instruction is, in effect, the use of the systems approach. Using this approach will require the planner, as Dale has said, to "think about the whole range of materials and . . . to orchestrate the whole business" (29). It will require a rigorous examination of the terminal behavior sought and an understanding of all different modes of presentation.

The goal of this process is the best blend of man and machine into a system which utilizes every method and medium of communication for the development of the learner's full potential. It is possible that in this process education may have a new and valuable tool in its quest for ways of providing all learners "access to excellence."

SYSTEMS APPROACH	INSTRUCTIONAL TECHNOLOGY
DEFINITION AND ANALYSIS OF PROBLEM	IDENTIFICATION AND ANALYSIS OF PROBLEM
STATEMENT OF OBJECTIVES	STATEMENT OF MAJOR GOALS STATEMENT OF INSTRUCTIONAL OBJECTIVES SEQUENCING OF OBJECTIVES
DETERMINATION OF POSSIBLE SOLUTIONS	DETERMINATION OF ALTERNATIVE METHODS OF PRESENTING INSTRUCTION
SELECTION OF BEST SOLUTION OR SOLUTIONS	SELECTION OF BEST METHOD OR METHODS
	CONSTRUCTION OF INSTRUCTIONAL UNIT OR UNITS
IMPLEMENTATION OF SOLUTION	IMPLEMENTATION OF INSTRUC- TIONAL UNIT OR UNITS
EVALUATION OF SOLUTION PERFORMANCE	EVALUATION OF PERFORMANCE
FEEDBACK	FEEDBACK

Figure 1

CHAPTER IV

A MODEL FOR DESIGNING INSTRUCTIONAL SYSTEMS

Over the past two decades many technological developments have crept into our schools. These technological developments have come into education in bits and pieces. Little thought has been given to applying the new equipment in any way other than as an "aid" to an old existing program. Almost no thought has been given to providing the "cafeteria of learning materials" of which Edgar Dale spoke, much less of heeding his plea that we must "orchestrate the whole business" (29). The potential of our technological developments for providing instruction in and of themselves has been largely overlooked.

When we "orchestrate" these new developments, we place them into systems that can provide instruction. In other words, we develop an instructional system: a man-machine system devised rigorously so that each component complements every other component to accomplish the intended instruction.

If instructional systems are to be devised rigorously, there must be a systematic plan or model to follow. In this chapter the goal will be to develop a model which should insure that instructional systems are designed rigorously and validated. The endeavor will therefore be to 1) outline the model and 2) explain each component and sub-component.

The Model

It was indicated in Chapter II that an adequate instructional model has three major characteristics. First, it will be diagnostic

in that it will provide for the identification of 1) instructional objectives, 2) instructional procedures, and 3) the learner's capabilities and current level of operation. Second, it will be prescriptive, in that it will specify the instructional procedures necessary to produce optimal learning conditions. Third, it will be normative in that it will provide a set or sets of criteria for determining when the objectives have been achieved. In Chapter III it was indicated that instructional technology and the systems approach were processes which could help in the analysis and synthesis of problems. The development of this model will utilize the characteristics of an adequate model of instruction as well as the characteristics of instructional technology and the systems approach.

The components of this model and the areas from which they are derived are tabulated below.

Component	Adequate Model of Instruction	Instructional Technology	Systems Approach
1. Identify and Analyze Problem		x	x
2. State Goals and Instructional Objectives	x	x	x
3. Content Analysis	x	x	
4. Select Instructional Strategy	x	x	x
5. Construct Instructional Strategy	x	x	
6. Test, Evaluate, Revise		x	x
7. Implement	x	x	x
8. Monitor System	x	x	x
9. Feedback		x	x

Figure 2 is a flow chart showing each of the nine components and their relationships. The primary flow of information or sequence of information or sequence of operations is generally forward but the

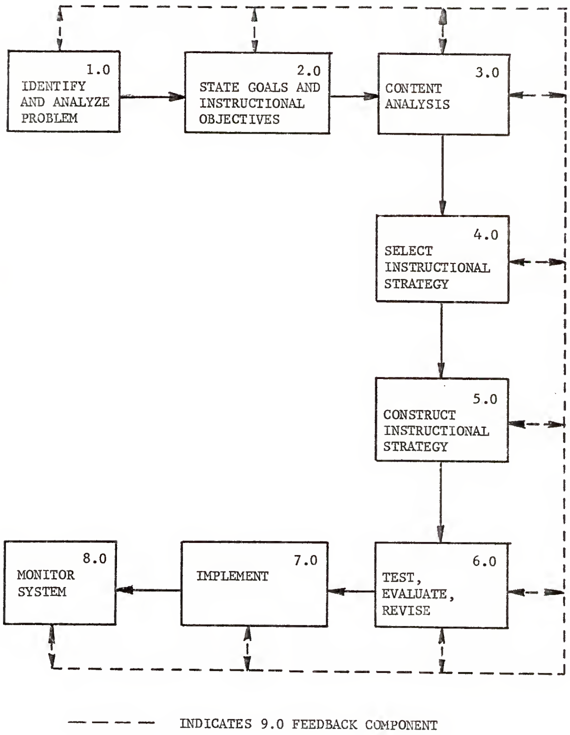
1.0
IDENTIFY AND ANALYZE PROBLEM
2.0
STATE GOALS AND INSTRUCTIONAL OBJECTIVES
3.0
CONTENT ANALYSIS
4.0
SELECT INSTRUCTIONAL STRATEGY
5.0
CONSTRUCT INSTRUCTIONAL STRATEGY
6.0
TEST, EVALUATE, REVISE
7.0
IMPLEMENT
8.0
MONITOR SYSTEM
INDICATES 9.0 FEEDBACK COMPONENT

Figure 2

feedback flow may be in both directions. An explanation of each component of the model along with any sub-components are given in the following section.

Explanation of the Model

This model is a general model that can be used at any level; national, state, county, school or teacher. Slight modifications may be necessary, particularly in the sequence of operations. The amount of modification will depend upon the level at which it is applied and the number of personnel involved in the system solution. As each component is explained, it must be remembered that the level at which the model is applied will determine somewhat the magnitude of the analysis conducted in each step.

Component 1 - Identify and Analyze the Problem

For the identification of the problem Roger Kaufman used two terms, "need" and "problem." He defined a "need" as ". . . the discrepancy between what is and what is required . . . " (67:415). This definition indicates that the difference between what is and what is required can be measured. It is shown in the following formula:

$$\boxed{\begin{array}{l}\text{WHAT}\\ \text{IS}\\ \text{REQUIRED}\end{array}} \quad \text{MINUS} \quad \boxed{\begin{array}{c}\text{WHAT}\\ \\ \text{IS}\end{array}} \quad \text{EQUALS} \quad \boxed{\text{NEED}}$$

Needs are derived in many ways. For example, a grade level of a school falling 30 points below the state average on the state achievement test indicates a need, the difference between where the school

rates on the test and the state average for that test. Another example is to be seen in a school district that does not offer any foreign languages and a new state requirement that each school would offer a minimum of one year of Spanish. The need is the difference between no foreign language offering and the requirement to offer one year of Spanish.

Kaufman defined the term "problem" as ". . . requirement to reduce or eliminate a discrepancy between what is and what is required to a specified level" (67:416). A problem, then, is the requirement to reduce or eliminate a recognized need. Using the above examples, statements of the problems might be: example one, to raise the grade level average on the state achievement test to that of the state average; example two, to offer a new course, first-year Spanish. Problems, then, are derived from recognized needs.

Needs may be derived from many sources: from tests, from requests of students and/or parents, from school and/or school district policies, from the state department of education, from legislative action, and from nationally discovered concerns, such as the national concern with physical fitness that developed in the 1960s or the national concern of the late 1950s for the development of more scientists. These are only a few examples of the sources from which needs may be derived.

Needs assessment determines what the needs are and their magnitude. The priority placed upon each need in relation to the other needs determines which needs are real problems. The process of needs assessment may vary from very rigorous to informal, but the more rigorous the assessment the more likely important needs and problems will be

discovered and specified. Once the true instructional needs and problems have been discovered and specified, the second component of this model, the stating of goals and instructional objectives, can be entered.

Component 2 - State Goals and Instructional Objectives

In this component the planner states the educational goals and the instructional objectives based upon a problem derived or specifically stated in Component 1. Movement through this component is through three sub-components: 1) State goals, 2) State instructional objectives, and 3) Sequence instructional objectives. The flow chart for this component is shown in Figure 3.

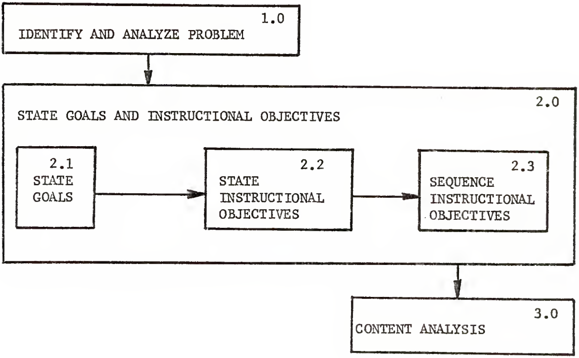

Figure 3

State goals

Educational goals are broad, general statements of instructional intent. As descriptions of intent they help to identify content topics and to refer to the instruction rather than to the consequences of that instruction. Educational goals are usually long range and cover large areas. Most often they are determined at the school, school district and state levels. These should be analyzed and a determination made as to which ones apply and/or what part of a broad goal will be useful in a particular block of instruction. If the educational goals have not been determined at a prior time, such would be accomplished through analysis and synthesis at this point in the design process.

State instructional objectives

Once the educational goals have been analyzed, the effort would be to state specific instructional objectives. Instructional objectives are also known by several other terms, such as behavioral objectives, educational objectives, and performance objectives.

An instructional objective is a description of the form of behavior that the instruction is to produce. Mager defined a behavioral objective by stating, "An objective is an intent communicated by a statement describing a proposed change in a learner--a statement of what the learner is to be like when he has successfully completed a learning experience. It is a description of a pattern of behavior (performance) we want the learner to be able to demonstrate" (80:3). Instructional objectives, then, are descriptions of intended outcomes rather than descriptions or summaries of content. Because an instructional objec-

tive is a description of the intended outcome, it must be written in terms of the performance required to demonstrate the accomplishment of the objective. It is not enough to state that the program is to produce good citizens, or well-rounded individuals, or music lovers. The objectives must be stated in terms of the performances which apply to the particular knowledge, skills and attitudes that are to be acquired.

The statement of an objective should specify what the learner is expected to do, how well he is expected to perform and under what circumstances he will be expected to perform. The what part can be specified by using verbs that denote observable action, by indicating the stimulus that will evoke the behavior, and by listing what is to be used. The how well part specifies the accuracy or degree of correctness of the response, including speed, rate, time and so forth. The under what circumstances part specifies the conditions, both physical and psychological, under which the performance will occur. A well-written instructional objective is a statement of performance expected, a statement of the conditions under which the performance will occur, and a statement of the criteria against which it will be evaluated.

Instructional objectives can be classified as being primarily in one of three large categories or domains: cognitive, affective, or psychomotor. Cognitive domain instructional objectives are concerned with intellectual processes. These processes include remembering or recall, understanding, problem solving, and other types of learning which involve the storage, processing, and retrieval of information. Affective domain instructional objectives involve feelings and attitudes. Psychomotor domain instructional objectives involve muscular or motor skills,

manipulation of materials or objects and acts which require neuromuscular coordination. They are stated in terms of abilities and skills. Although instructional objectives can be classified as being primarily in one domain, they usually will reflect some part of one or both of the other domains.

All three domains have been so analyzed that instructional objectives can be placed into taxonomies from low to high complexity. The use of this model will be facilitated if the writer of instructional objectives is familiar with the following: 1) Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook I: Cognitive Domain (9), 2) Taxonomy of Educational Objectives, The Classification of Educational Goals, Handbook II: Affective Domain (70), and 3) The Classification of Educational Objectives, Psychomotor Domain (95). The writer of instructional objectives should insure that objectives are written which include all levels within the taxonomies of the three domains.

There are many reasons why we should write specific instructional objectives.

1. For the learner they:
    a. inform him of the purpose of each learning activity
    b. tell him what he should be able to do upon the completion of a particular learning activity
    c. enable him to know when he has met the objectives
    d. help him to study selectively and thus distinguish between core and enrichment materials
    e. help him to self-evaluate his own progress
    f. provide feedback on results

g. help him to direct his efforts toward appropriate goals
h. help him to understand the basis for evaluation of his performance.

2. For the teacher they:
   a. provide communication as to the purpose of the materials
   b. provide criteria for determining when the student has met the unit or course objectives
   c. provide help in guiding the efforts of the learners
   d. provide help in reviewing testing and evaluation procedures so that they will be relevant
   e. help to establish a basis for remedial instruction
   f. provide a basis for grade placement
   g. provide a basis for appraisal of prerequisite skills
   h. provide a basis for promotion
   i. provide a basis for planning for the future needs of the learner
   j. provide a basis for knowing when changes of objectives or changes in methods and materials are needed
   k. help to protect against unjustified criticism
   l. provide a basis for responding to questions about what is being accomplished.
3. For program or material development projects they:
   a. provide a basis for organizing and managing the work
   b. provide direction to the project
   c. provide a basis for assigning work
   d. provide a basis for supervising the work of specialists

e. provide a basis for knowing when draft materials have been completed

f. provide a basis for sequencing materials

g. provide a basis for selecting media

h. provide a basis for prescribing the preparation of materials

i. provide a basis for evaluating field testing

j. provide a basis for periodically reviewing the usefulness and relevance of all developed materials

k. provide a basis for making partial revisions required by changed conditions or new data

l. provide a basis for determining prerequisite skills.

<u>Sequence instructional objectives</u>

In this sub-component the planner places the instructional objectives into a sequence according to the structure of the body of knowledge and according to their logical order of accomplishment. After the instructional objectives have been ordered, the planner reviews them to ascertain if all necessary objectives have been included. The accomplishment of this and the previous sub-component will require that the planner have a detailed understanding of the body of knowledge.

<u>Component 3 - Content Analysis</u>

In this component the planner analyzes each of the instructional objectives stated in Component 2. This analysis is made for the purpose of determining <u>all</u> the learning tasks which the learner will need to learn in order to be able to show successful performance of the instruc-

tional objectives. Movement through this component is through four sub-components: 1) Learning task analysis, 2) Sequence inventory of learning tasks, 3) Criterion test, and 4) Entry level competencies. The flow chart for movement in this component is shown in Figure 4.

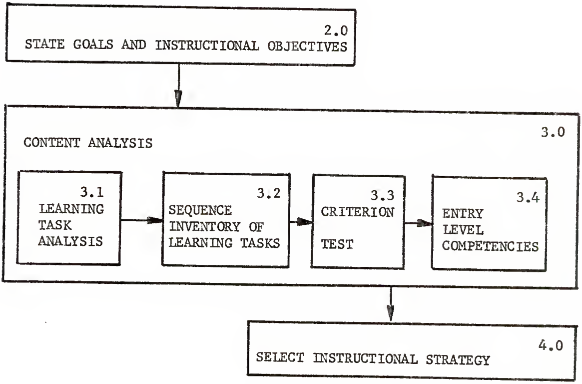

Figure 4

<u>Learning task analysis</u>

To determine the content of the instructional system, it is necessary to analyze each of the instructional objectives to determine the learning tasks required for each one. In stating the instructional objectives, the planner is looking primarily at the terminal behaviors which the learner is to develop. The perspective now changes so that the planner determines <u>all</u> the sub-tasks needed for that terminal objective. Learning task analysis, then, means breaking down an objective

(a learning task) into smaller component tasks, each of which must be mastered as a prerequisite to successful mastery of the total task or objective. The question the planner needs to ask here is, "What competencies or sub-tasks must the learner have achieved to complete successfully the objective?"

Some objectives require few sub-tasks; others will require many sub-tasks. This is shown graphically in Figure 5. The mastery of Objective A requires three sub-tasks, but mastery of Objective B requires twelve sub-tasks. All sub-tasks, whether they are sub-tasks for the objective only or are sub-tasks of a sub-task, must be listed. The complete list of learning tasks is the inventory of learning tasks needed for successful accomplishment of the objective. The inventory of learning tasks will be used in the next sub-component.

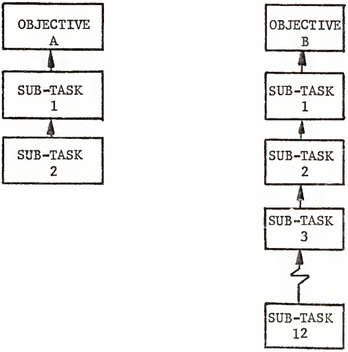

Figure 5

<u>Sequence inventory of learning tasks</u>

In this sub-component the planner places the complete inventory of learning tasks into a sequential hierarchy. It must be noted here that some sub-tasks are prerequisite learnings for other sub-tasks; for other sub-tasks no prerequisite learning sub-tasks are needed. Each sub-task must be examined for its relationship to all the other learning tasks.

In compiling the inventory of learning tasks, the planner answers the question, "What competencies or sub-tasks must the learner have achieved to complete successfully the objective?" After this is done, he must ask and answer several related questions about each learning task; 1) "What competencies or learning tasks must be achieved prior to the one in question?" 2) "What competencies or learning tasks can be achieved only after prior achievement of the one in question?" and 3) "What competencies or learning tasks are independent of the one in question and therefore may be taught without regard to the sequence of the other competencies?"

The answers to these three questions should provide the structure of the learning tasks for an objective. This is depicted in Figure 6.

This figure illustrates that the successful attainment of Objective B is dependent upon twelve specific competencies or sub-tasks. Sub-Task 1 is independent and requires no prerequisite learnings. Sub-Task 2 is dependent upon the prior learning of Sub-Tasks 4, 5, 6, 9, 10 and 11, of which 9, 10 and 11 must be achieved prior to Sub-Task 4. Sub-Task 3 is dependent upon Sub-Tasks 7, 8, and 12, of which 12 must be achieved prior to 8. This illustration shows the structure and

relationships of the learning tasks needed to accomplish Objective B successfully.

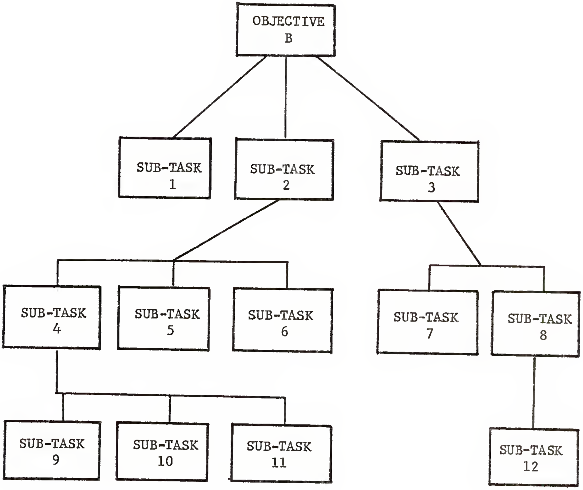

Figure 6

Such an analysis and synthesis must be performed for all instructional objectives in the unit or course. The successful sequencing of the inventory of learning tasks should enable the learner to progress through the instruction with ease.

Criterion test

When the planner has developed and sequenced the inventory of learning tasks, he is ready to develop the criterion test. In this sub-component he develops the criterion test and checks it to be assured that it measures all of the sub-tasks required to assure performance of the objective.

A criterion test is an examination used to evaluate the attainment of each sub-task required by an objective. There are three primary functions of a criterion test: 1) to help the planner design the instruction, 2) to help determine the ability of the student to perform the course requirements, and 3) to help evaluate the effectiveness of the instruction. These three functions should all be found in an adequate criterion test.

A criterion test should include criterion items from each of the sub-tasks required to achieve the instructional objectives of the course or unit. Using Objective B again as an illustration, a criterion test for Objective B would contain one or more items testing each of the sub-tasks (1-12) needed to accomplish Objective B. It should include criterion items which test all of the sub-tasks which the student must accomplish in reaching the objective. The performance required by the objective for each sub-task must be the performance required in the criterion items for that sub-task. In other words, the performance required on the criterion test must match the performance required in the objective. If the objective requires the learner to "list," then the criterion test must not require him to "describe," since these two

requirements do not match. All of the objectives must be tested and all performances required on the criterion test must match those required by the objectives.

Entry level competencies

When the planner has developed and sequenced the inventory of learning tasks and has developed the criterion test, he is ready to determine the level of performance the learners must have to enter the unit or course. In this sub-component of Component 3, he will determine the entry level test. The entry level performance required will determine the competencies the learner must have acquired prior to beginning the new unit. The entry level test will be used to test the learner to determine if he has acquired the required competencies. If he has, he enters the new unit; if he has not, he must be given some remedial work so that he may acquire the missing competencies before entering the new unit. Entry level, then, is the knowledge and skills that the student brings with him when entering a course of instruction.

Because each student is an individual and develops differently, the level of each student entering a new course will be different. One student may have attained already some of the knowledge and skills required for the course. Another student may have attained only the knowledge and skills required to enter the new course. A third student may not have attained all the knowledge and skills required to enter the new course. Knowing this about each of the three students would enable the teacher to start each student at his proper level. Knowledge of each student's entry level skills affects new instruction in that it tells the teacher the student's position relative to the initial

objectives of the course.

To determine the entry level performance requirements, the planner will examine the inventory of learning tasks and the previous instruction that the learners have had. From these two items, he can assume that the learners will have attained certain competencies. These competencies are designated as the entry level performance required to enter the new course. Using the previous illustration of the sub-tasks for Objective B as an example, the planner looks at all the sub-tasks needed to achieve Objective B and at the instruction the learners have had in the past. From these examinations, he determines that Sub-Tasks 9, 10, 11 and 12 should have been attained already by the learners. Attainment of these sub-tasks, then, becomes the required entry level of the learners. All of the other sub-tasks become the requirements for the course. In our example, then, Sub-Tasks 1-8 become the course requirements.

COMPLETE INVENTORY OF LEARNING TASKS	MINUS	ENTRY LEVEL REQUIREMENTS	EQUALS	COURSE CONTENT

To determine if these sub-tasks have been attained, the planner will develop an entry level test. The entry level test will test the learner to find out if he has achieved each of the sub-tasks. It will be necessary to test in detail for achievement of each of the sub-tasks. This cannot be a sampling. Each sub-task must be tested. Because we should also consider the possibility that a learner may have the com-

petencies which would be taught early in the course, the entry level test should also include the early course requirements. The entry level test can easily be constructed from the criterion test for the unit or course. It would consist of those criterion test items that test the entry level performance and the early course requirements.

In our example, then, the entry level test would include the required entry performance (Sub-Tasks 9, 10, 11 and 12) and the early course competencies (Sub-Tasks 4, 5, 6, 7 and 8). From an entry level test of this nature the teacher would be able to adjust the course requirements, basing this adjustment upon the known performance of the learners. For example, using the entry level test results of three students, it was found that student A achieved all entry level requirements and also Sub-Tasks 7 and 8, student B achieved all the entry level requirements, and student C achieved Sub-Tasks 10, 11 and 12 but did not achieve Sub-Task 9. From this information the teacher would know that it would not be necessary for student A to study Sub-Tasks 7 and 8 because he already had these competencies. His course requirements would therefore be shortened. Student B would need to study all the competencies in the course because he has achieved only to the entry level. Student C will need to study Sub-Task 9 before he can enter the course.

The primary advantage in determining the student entry level is that it enables us to decide which sub-tasks need to be included and which can be excluded from the course. The student entry level capabilities may be determined by administering an entry level test. From the results of this test we may determine whether the assumed entry level is too high or too low for each student. If it is found that the entry

level assumptions are too low, the course can be adjusted by deleting the unnecessary sub-tasks. If it is found that they are too high, the course can be adjusted by adding the necessary sub-tasks. This capability to adjust the instruction helps to individualize it.

Component 4 - Select Instructional Strategy

In Component 4 the planner determines the strategy to be employed in the actual conduct of the instruction. An instructional strategy must be developed for each of the sub-tasks. One of the purposes for writing specific instructional objectives and analyzing them to determine the necessary sub-tasks or sub-objectives is to help the planner determine the method of instruction to be employed. Movement through this component is through three sub-components: 1) Determine possible strategies, 2) Evaluate possible strategies, and 3) Select best strategy. The flow chart for this component is shown in Figure 7.

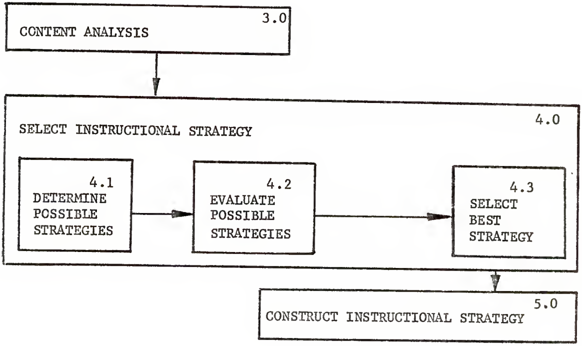

Figure 7

The planner has already made a thorough analysis of the educational goals, written specific instructional objectives, determined the required learning tasks and sequenced them in relation to each other and the body of knowledge. The next step, designing the instructional strategy, is aimed at the achievement of the learning tasks and objectives. A wide variety of possibilities exists from which the planner must choose. At this time it will suffice to point out that the instructional activities should require participation on the part of the learner and should take advantage of the multiple instructional alternatives available by utilizing the full range of media and technology. In this context the teacher will be considered along with other forms of media.

Determine possible strategies

In this sub-component the planner analyzes individually the learning tasks to determine all of the learning activities that could be used to accomplish each learning task. Consideration should be given to all forms of activities: lecture; demonstration; viewing films, slide sets, filmstrips, video tapes, and television; listening to audio tapes and radio programs; performing laboratory experiments and shop activities; large and small group activities; participation in discussions and field trips; etc.

Not all of the possible activities will be appropriate for each learning task. Only those which are appropriate should be considered. The planner should devise a method for accomplishing this task. One such method might be the use of a system like the one illustrated in Figure 8.

LEARNING TASKS	ACTIVITIES	INSTRUCTIONAL MATERIALS
LEARNING TASK #1	ACTIVITY 1A	MATERIALS 1A1 1A2 1A3
	ACTIVITY 1B	MATERIALS 1B1 1B2 1B3 1B4
	ACTIVITY 1C	MATERIALS 1C1 1C2 1C3
LEARNING TASK #2	ACTIVITY 2A	MATERIALS 2A1 2A2
	ACTIVITY 2B	MATERIALS 2B1 2B2 2B3

Figure 8

In this system the planner would list in column one the first learning task, in column two the first activity that could be used to help accomplish that learning task, and in column three all the materials needed for that activity. He would then go back to column two and list another activity. Then in column three he would list all the materials for the second activity. When he has listed all the possible activities for the first learning task and all the materials for each activity, he would return to column one and list the second learning activity and

complete columns two and three for the second learning task. He would continue this process for all learning tasks until all possible alternatives were listed.

Evaluate possible strategies

In this sub-component the planner evaluates each instructional activity and necessary materials. The purpose of this evaluation is to provide information for selecting the specific activities necessary for accomplishing the learning task.

Several aspects should be given consideration: 1) student characteristics and numbers, 2) time available, 3) characteristics of media, 4) availability of learning spaces, 5) availability of equipment, and 6) cost.

Student characteristics and numbers.--Not all student characteristics can be spelled out. But the planner should take into consideration the age, grade level, maturity, background, physiological development, and visual and audio acuity of the learners. Another consideration of the planner must be whether instruction will be in a large group, a small group or on an individual basis.

Time available.--This aspect includes such considerations as 1) the length of time required to accomplish the activity, 2) the amount of time that can be used within the course for that activity, 3) if it is a program to be acquired, the amount of lead time needed, and 4) if it is to be a locally-produced program, the amount of production time needed.

Characteristics of media.--Each form of media has its own set of characteristics and should be considered in that light. For example,

one of the characteristics of movie films is the ability to show motion, but if motion is not needed this might not be the best form of media to use. In addition to this kind of characteristic, consideration must be given to certain advantages and disadvantages which each form of media may have. The planner must be familiar with these characteristics, advantages or disadvantages; if not, he will need to secure the services of a media specialist to help in making decisions about which media to use.

Availability of learning spaces.--This requirement makes necessary a consideration of the physical school plant. Are there spaces for large group instruction? Small group? Individual? Is there a learning resource center? Do the classrooms have computer terminals? Are the facilities crowded? Are they available for other than "school hours?" These are but a few of the questions the planner might pose in his effort to secure the needed information.

Availability of equipment.--The planner needs to know what equipment is available, the condition of the current equipment, the attitude of the faculty toward using equipment and toward student use of equipment. He also needs to consider the money available for future purchase of equipment and the specific equipment already programed for purchase.

Cost.--A comparison of the cost of the various forms of media must be considered. One of the aims for developing this model is to provide the best quality possible. This means to increase quality and efficiency with little or no increase in cost. Johnson and Johnson have provided a simple-to-use "Model For Media Set Cost Comparison" (65:107-108). The planner should use such a model in considering relative costs of the various forms of media.

Select best strategy

Having determined all possible strategies and evaluated their comparative relationships, the planner is ready to select the strategy to be used. If it is possible to select and implement only one of the alternatives, the most promising should be selected. If it is possible to select and implement more than one alternative, the planner should select one as the primary form and others as alternate means. This would provide for more individualization for the learners.

Component 5 - Construct Instructional System

In Component 4 the planner determined what the possible strategies might be, evaluated their possibilities and selected the ones that were most promising. In Component 5 the planner produces the materials (software) for the implementation of the selected strategies. The flow of work is in two sub-components: 1) Off-the-shelf materials and 2) Locally produced materials. The flow chart for this component is shown in Figure 9.

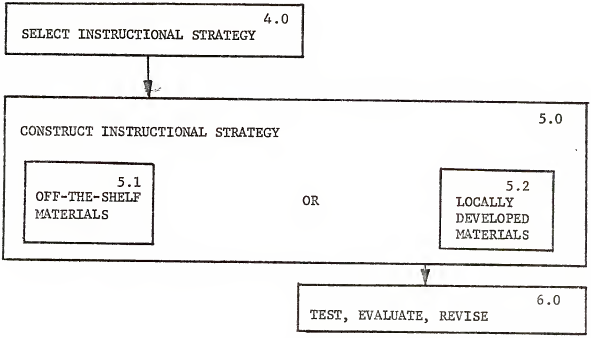

Figure 9

Off-the-shelf materials. The planner should, in the interest of time, consider commercially prepared materials. He knows the strategy to be used, e.g., film, slide, audio tape, etc., and thus can begin to locate materials produced by commercial companies. These companies have produced materials in all forms and this has greatly increased the availability of materials in most content areas. But their selection is not an easy matter. There are some definite drawbacks to the process of commercial materials selection.

The largest single drawback is the fact that commercial materials are not indexed by instructional objectives. They are usually indexed by topic. This means that such materials will need to be previewed in order to determine whether or not they will produce the desired outcome. Frequently commercial producers will provide the materials for a short period of time at no charge or for a very nominal charge. Materials should always be previewed before purchase. If this cannot be arranged through the company, the planner should look to a lending or rental library as a possibility for securing the materials for preview.

The techniques of media selection can be found in most media textbooks. These techniques should be followed. But the basic question to be answered is whether or not the particular material being evaluated will produce the specific outcome required. If it does not meet this basic criterion, it should not be selected.

The evaluation of commercial materials will produce some of the materials for the instructional system. Those programs that cannot be secured commercially must be developed locally.

Locally developed materials.--Some materials will not be available

from already prepared commercial materials. This will require the planner to prepare written specifications for the materials to be produced. These specifications will be used by the specialists, film makers, photographers, etc., who will prepare the first-draft materials. These specifications should include all the necessary instructions that the specialists would need.

Once the draft has been prepared, the planner should preview the materials, keeping in mind the basic question of whether or not the specific materials will produce the desired outcome. It is possible at this point to revise the materials if they fall short.

When the selection process has been completed for both commercial and locally produced materials, the planner will secure only enough materials to conduct the testing, evaluation and revision phase. It is possible to carry out this next phase for locally produced materials prior to final production of these materials. Commercially produced materials should be bought only in quantities large enough for the testing phase.

Component 6 - Test, Evaluate, Revise

The purpose of this component is validation of the system. Validation is needed to insure that the instructional intent is achieved. The success of the system depends upon the success of the learner. If the learner is not successful, the planner must reevaluate the instruction to determine what went wrong and how it can be corrected. To evaluate the instruction, the planner must compare the learner's actual achievement with the outcomes specified by the objectives.

The validation process is a test-evaluate-revise cycle. The system is tested by trying it out. Records are kept for use in evalu-

ation. If there are weak points in the instruction, they must be revised. Information from the evaluation feeds back to any previous component in the design process so that analysis and synthesis may take place and changes rigorously planned.

Validation testing will be conducted in two phases. The first phase utilizes individual testing. The second phase makes use of a group test.

Individual testing

In this phase individuals who can demonstrate the entry level behaviors are selected. Records are kept on each individual learner as he proceeds through the instructional system. Conferences with the individual learner provide needed information about the system. The evaluator is then able to assess the instruction and can determine where change is needed. Revisions are made and the process repeated with a new set of individual learners. When it appears that this procedure is no longer productive, the second phase, group testing, will be entered.

Group testing

In this phase entire classes are selected for participation. The records kept in this phase are oriented toward the performance of the entire group, and must reflect performance on each learning task and objective. The performance achieved is compared with the expected performance. Individual learning tasks or objectives which are weak are revised and the process repeated with a new group of learners.

The question of when to stop this process must be considered by the planner. The goal should be to make the instruction so effective

that 100% of the learners will be able to achieve 100% of the intended outcomes. This goal may be too high, but it should be considered as the ultimate goal. A more realistic goal may be one closer to the goal used by the military services, 90-90, meaning that 90% of the learners achieve a minimum of 90% of the intended outcomes. Even this reduced goal is much higher than what is now set in many schools. The planner will be the one to set the standard.

The flow of activity through this component is shown in Figure 10.

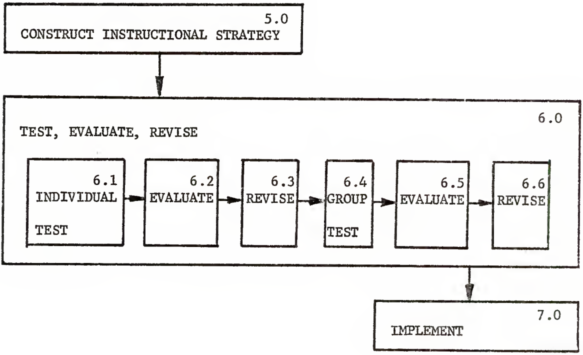

Figure 10

<u>Component 7 - Implement</u>

Implementation of the instructional system will usually require decisions at the school or school district level. There are several factors which will influence the decision to implement the system. The

cost of implementation will need to be considered. These costs will include such items as cost of equipment, cost of materials, cost of building modification, cost of installation of equipment, and special training of personnel. Once these factors have been determined, it will be necessary to decide between three alternatives: 1) to implement the entire system, 2) to implement the system in phases, or 3) not to implement the system.

After the decision to implement has been made, most of the work flow in this component will be conducted through four sub-components. These sub-components are shown in Figure 11.

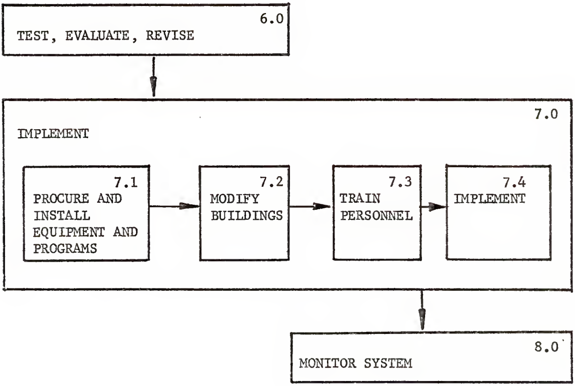

Figure 11

Sub-components 7.1, 7.2 and 7.3 would be conducted simultaneously, but sub-component 7.4 could not commence until the work in the other

three had been completed. The magnitude of 7.1, 7.2 and 7.3 will depend upon the design of the system.

Procure and install equipment and programs

In this sub-component the equipment and programs would be purchased. The purchasing department of the school district would be responsible for this phase and would see that all regulations for such purchases are followed. For example, it would prepare and let bids and would receive and distribute the equipment and programs to the proper schools upon the instructions of the project director.

If the materials are to be made locally, the project director would need to instruct the specialists who are to do the work. He would need to give them the specifications that had been developed in Component 5.

Regardless of whether the equipment and programs are purchased, or the programs produced locally, there must be enough lead time so that all necessary equipment and materials will be on hand and ready for use when the implementation date arrives.

Modify buildings

This sub-component depends entirely upon two factors, the programs in the system and the buildings to be used. Much of the time there will be little or no building modification. But if the system should require this, it must be completed prior to the implementation date.

Train personnel

Special training sessions should be conducted on large enough scope to train all the school personnel who will work in the system.

These training sessions would possibly be conducted as a summer workshop. Any special techniques or skills would be taught. Materials and equipment used in the validation phase could be used for these workshops.

Implement

This sub-component would require that a date for implementation be established, that the equipment and materials be present, that personnel be trained, that any building modification be complete and that students be present and scheduled. This is the point toward which all the components have been directed.

Component 8 - Monitor System

For the systems approach to be effective the implemented system must be monitored as it operates. There must be continuing observation to insure that the system provides the outcomes that it was designed to provide. This will require that records be kept concerning student achievement. If these records show that the students are not achieving the specified objectives, the program must be revised. If it is found that the information upon which the program was based has changed, the program must be revised. This will keep the programs relevant.

Component 9 - Feedback

The systems approach requires the information flow to be such that changes in the systems can be accomplished as they are needed. Figure 2 on page 66 shows the entire model. The broken line in that figure indicates the feedback of information to other components. The flow of feedback information can be in both directions.

CHAPTER V

SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

Summary

Over the years we have heard much criticism of public education. Today we are hearing criticism both from educators and non-educationists. Many of the critics are suggesting that public schools must become more efficient and that the schools and teachers must become accountable for the results obtained.

The systems approach has been suggested by a number of educators as a tool or method which might have value for those who are looking for ways of achieving accountability in education.

The central purpose of this study was to develop a model for designing instructional systems. To this end the writer has investigated 1) historical and present models of instruction for the purpose of determining the components of an adequate model of instruction and 2) instructional technology and the systems approach as processes.

From the investigation of models of instruction it was found that an adequate model should have three characteristics. It should be 1) diagnostic, 2) prescriptive and 3) normative. It would have at least the following four components: 1) a statement of instructional objectives, 2) a procedure for evaluating student capabilities, 3) a description of instructional procedures and 4) a method for assessing achievement.

The investigation of instructional technology and the systems approach indicates that both are closely related processes. The use of

the systems approach has developed rapidly since World War II; instructional technology, as a process, has evolved slowly since its conception in the very early part of this century when curriculum construction leaders like W. W. Charters began thinking in terms of educational engineering. Similarity between the two processes was shown by tabulation in Figure 1 on page 63.

A nine-component model for designing instructional systems was developed. The bases for this model were 1) the adequate model of instruction, 2) the process of the systems approach and 3) the process of instructional technology. The nine components are 1) Identify and analyze problem, 2) State goals and instructional objectives, 3) Content analysis, 4) Select instructional strategy, 5) Construct instructional strategy, 6) Test, evaluate, revise, 7) Implement, 8) Monitor system, and 9) Feedback. Each component was described and its relationships were shown.

The model satisfies the criteria for model-building as presented in Chapter II. It can be used by an individual teacher or by committees working at the local school, county or state levels. Its use should insure instructional systems which are devised rigorously and validated prior to full implementation. Systems which are rigorously devised and validated should help to make public education more efficient and enable a higher degree of accountability.

Implications

This investigation suggests that this country may stand on the threshold of a new era in the design, validation and implementation of instruction--the era of instructional systems. The following are some

of the major implications for this new era.

1. There will be continuing research in the design, validation and implementation of instructional systems. This research will be conducted at several administrative levels, national, state, county and university.
2. There will be an increased use of mediated packages. These packages will be comprised of components which are interrelated and validated. Each package will be designed to make the maximum contribution to the achievement by the learner of specified instructional objectives.
3. Research will continue to be conducted to determine individual learning styles.
4. Our technological society will continue to produce more and more sophisticated equipment to be used in the transmission of information. Correspondingly, there will also be a trend toward many of these devices being designed specifically for school use.
5. Even more important are the benefits which may be derived from the use of technological devices. One of the benefits may be freeing "human" teachers to perform crucial and distinctly human tasks. This would include such tasks as diagnosing cognitive, social and emotional problems which can impede student learning and helping learners to increase their interpersonal skills so that they may become more effective members of our society.
6. The current practice of placing learners in self-contained

or departmentalized classrooms will continue to change. This change will have a corresponding effect upon the size and composition of student groups and upon the locations at which learning activities will take place. It will also expand the opportunities for independent study and continuous progress learning.

7. To accommodate these new teaching-learning approaches changes will be required in the design of the physical plant. There will be an expansion of learning centers. These will contain wet and dry carrels and be richly stocked with learning resources. Other areas will provide for more flexible arrangements of learner groups, including special facilities for both large- and small-group activities. Carpeting, sound treating, and lighting and ventilation controls will be found throughout the physical plant.
8. Due to the expanded facilities and equipment, administrators will need to give increased attention to developing more effectively coordinated educational media programs. These programs will provide the learning resources, the equipment, the media production areas and the logistical services necessary for the successful operation of instructional systems.
9. The large scale development of instructional systems will see the emergence of developmental teams which will involve the services of communicators with differing types of expertise.
10. Teacher training institutions will produce programs of teacher

training which will provide the prospective teacher with the necessary orientation to and understanding of instructional systems, as well as develop the professional skills necessary to function effectively in the new learner-centered instructional systems.

Recommendations

With respect to the above implications, the writer makes the following recommendations.

1. If research in the design, validation and implementation of instructional systems is not to be duplicated at the various administrative levels, a coordinating effort will be required. Universities are in a position to perform this function for the area they serve. Therefore, it is recommended that the various administrative levels cooperate in these research activities and that the universities not only perform research but also provide the coordinating function.

2. It is recommended that, as mediated packages are designed and validated, they be made available to other school systems either through cooperative agreements or through commercial companies.

3. Because part of the success in designing instructional systems will depend upon recognizing and understanding individual learning styles, there must be an increase in the amount and depth of research concerning the learning styles of individual learners.

4. Because more technological devices will be designed specifically for school use it is recommended that the designers and producers of this equipment work more closely with school personnel so that devices can be used without requiring much adaptation.

5. As these new teaching-learning approaches are implemented the role of the teacher will change; therefore, research to determine the vital aspects of this new role should begin immediately. Research in this area should not only define the new role but should help to disquiet the fears that instructional systems will replace the teacher.

6. Changes in the physical plant will necessitate research in the design of the physical plant and the logistical services needed to support the comprehensive use of instructional systems. Unless such research is begun immediately the full implementation of instructional systems may be impaired.

7. Administrators, curriculum developers and teachers need adequate preparation in the development, design and implementation of instructional systems. Without adequate preparation even the most willing designer will not be able to exploit the full potential of instructional systems. Therefore, teacher preparation institutions must develop such training programs.

Concluding Statement

The model developed in this study is just that--a model--a guide to be used by the designer of an instructional system. It is not intended to serve as _the_ instructional design but rather to promote the systematic design and validation of instruction and to serve as a guide in producing more effective instruction. It is hoped that this model will help instructional designers to plan instruction which is learner-centered, relevant, and meaningful for all students.

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BIOGRAPHICAL SKETCH

Carroll Fleming Cumbee, Jr. was born on December 6, 1929, at Lake City, Florida. He was graduated from P. K. Yonge Laboratory School, Gainesville, Florida, in 1947 and entered the University of Florida. In 1955 he received the degree of Bachelor of Arts in Education with a major in social studies and entered the Graduate School of the University of Florida. In 1958 he received the Master of Education degree with a major in foundations and a minor in industrial arts.

In September, 1955, he moved to Orlando, Florida, where he taught junior high school industrial arts for thirteen years. During this period he was an active member of the Florida Education Association, the Florida Industrial Arts Association, the Orange County Classroom Teachers Association and the Orange County Industrial Arts Association. From 1962 through 1965 he served as a member of the Florida State Department of Education Advisory Committee for Industrial Arts. In 1966 he served as a participant in the NASA-sponsored Symposium on Industrial Arts held at Cape Kennedy, Florida.

In 1951 he received a commission in the United States Army Reserve, and served on active duty during the period 1952-1954. Upon completion of active duty, he continued to serve as an officer in the U. S. Army Reserve Program and has attained the rank of Major.

He is an active member of the United Methodist Church, having held many different offices including Secretary of the Official Board, Church School Superintendent, and Chairman of the Pastoral Relations Committee.

In 1968 he entered the University of Florida and began work on his doctoral program. During the period of this program he has served as a

graduate assistant, graduate teaching assistant, and adjunct professor for the Educational Media Center of the College of Education.

He has been elected to membership in Phi Delta Kappa and Kappa Delta Pi, honorary educational fraternities. He is also a member of the Association for Supervision and Curriculum Development, the Association for Educational Communications and Technology, the National Association for Educational Broadcasters, and the Florida Audiovisual Association.

He is married to the former Margie Elberta Barden of Columbia, South Carolina, and has two sons, Carroll III, seventeen, and Robert, thirteen.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

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Charles L. Durrance, Chairman
Professor of Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Education.

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